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SPECIFICATIONS

FOR

RAILROAD AND CANAL

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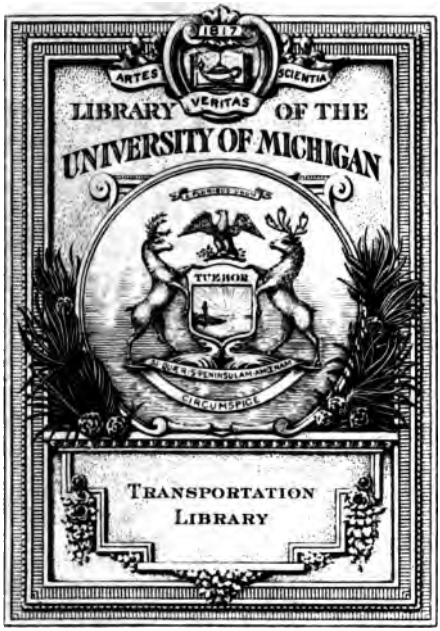
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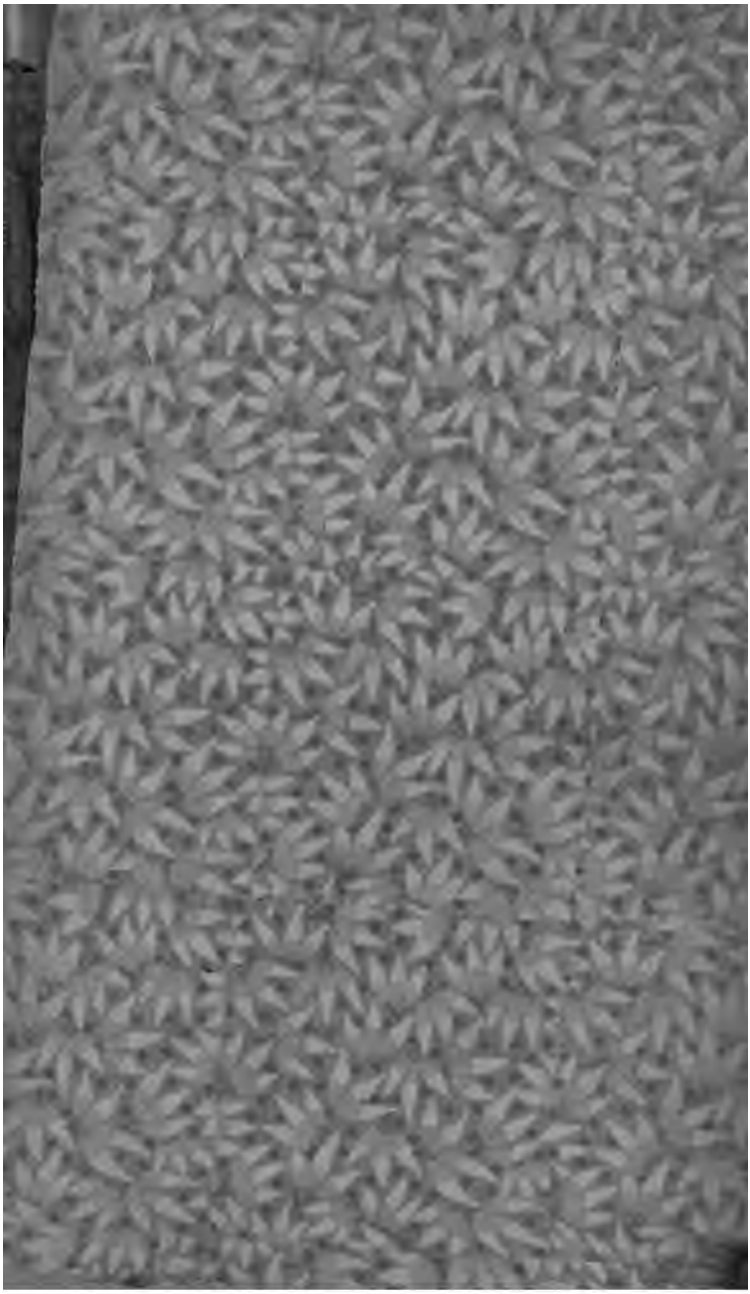

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STANDARD SPECIFICATIONS

FOR

RAILROAD & CANAL CONSTRUCTION.

FOR THE USE OF

CONTRACTORS AND CIVIL ENGINEERS.

RAILROADS:

FORM FOR CONTRACTS, AGREEMENTS, RIGHT-OF-WAY AND LEASE, WITH SPECIFICATIONS FOR CLEARING, CLOSE CUTTING, GRUBBING, GRADING, TUNNELING, MASONRY, PILING, FOUNDATIONS, TIMBER WORK, FENCING, TRACK-LAYING, BALLASTING, TIES, RAILS, ETC.

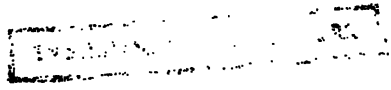
CANALS:

FORM FOR CONTRACT; ALSO SPECIFICATIONS FOR SECTION OF CANAL, CULVERTS, LOCKS, WASTE WIERS, AQUEDUCTS, DAMS AND HIGHWAY BRIDGES.

COMPILED BY

JOHN A. YATES, *C. E.*

CHICAGO:
THE RAILWAY AGE PUBLISHING COMPANY,
1886.



PREFACE.

For the compilation of the following Specifications I am indebted to several members of the profession who, by their courtesy, have assisted me in obtaining the material herein contained and by the presentation of which they unite in hoping some benefit to others may be derived.

A large portion of this work has been originated by several of my colleagues. The number is so great I cannot give them individually personal recognition, yet I desire to express to them my appreciation of their intelligence and ability, feeling confident that they will derive satisfaction in knowing that their efforts have benefited their professional brethren and others.

Considerable difficulty is experienced at times in forming an Article of Agreement, with its accompanying Specifications, which shall be so worded as to be thoroughly understood by the Companies, Engineers and Contractors and leave no latitude for future cavil or complaints. In view of this I have, after careful examination of the forms in use on the several trunk lines, made a selection from their Agreements and Specifications, which in my opinion covers all questions that may arise during the progress of the work of con-

struction. This is especially so in the forms for Agreements. Should the material appear too voluminous, it is at the option of the Engineer to curtail it if he desire.

The second form being more concise, may be considered by some adequate and possibly more satisfactory.

Full information on this subject is essential to an Engineer, and while Specifications have been presented creditably before they have generally been compiled with other matters, making the material too limited to answer all requirements.

To the young and inexperienced Engineer, who has had a difficulty in obtaining some established form or precedent, I am confident of rendering some service. To the older member of the profession who may consider himself fully informed a careful examination of this work may give suggestions not at present contained in his papers.

The Canal Specifications are adapted from those in use on the New York state canals, and contain information on Forms for Agreements, Specifications for masonary foundations, etc, sufficient to make them applicable to other public works.

JNO. A. YATES.

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INDENTURE FOR RIGHT OF WAY.

FORMS FOR PROPOSALS.

GENERAL CONTRACTS.

SCHEDULE OF PRICES—WITH CONDITIONS.

Indenture for Right of Way.

THIS INDENTURE, made this.....day of ....., 18..., between ..... and ....., his wife, parties of the first part, and the.....Railroad, by.....their authorized agent, parties of the second part,—

WITNESSETH,—

That for and in consideration of the cash sum of..... dollars ($.....) in hand paid to said parties of the first part by....., the said agent for the parties of the second part, and for the further consideration of the benefits to be derived by the said parties of the first part from the construction and running through their lands of a railroad to be constructed in the near future, the said..... and....., his wife, do hereby grant and convey unto the said .....Railroad the clear, unobstructed right of way across and through the said lands, as it now is surveyed and located, said pieces of land to be .....feet wide each side of the center line of said railway; and said land to be so held and so used as will most facilitate the construction and operation of the railroad.

Witness our hands and seals this..... day of....., 18....

.....(L. S.)

.....(L. S.)

Signed and sealed in the presence of

.....

.....

Proposals for Grading, Masonry, Timber Work, etc.

For ..... Railroad Company.

The undersigned propose to the ..... Railroad company, to perform all work of grading, masonry, timber work and fencing for the above railroad, according to the specifications, at the prices affixed to the following schedule, to wit:

	$	cts.
For clearing, per acre	....	....
For grubbing, per station	....	....
For earth excavation, per cubic yard	....	....
For tunnel excavation, " "	....	....
For loose rock excavation, " "	....	....
For solid rock excavation, " "	....	....
For loose stone in aprons, rip rap, cribs and elsewhere, per cubic yard	....	....
For building board fence, per lineal rod	....	....
For snake or rail fence, " "	....	....
For gates, with posts and fixtures complete	....	....
For first class masonry, per cubic yard	....	....
For second class masonry, " "	....	....
For third class masonry, " "	....	....
For 4th class masonry (in cement) ℔ cubic yrd.	....	....
For 4th class masonry (laid dry) " "	....	....
For 5th class masonry (in cement) " "	....	....
For 5th class masonry (laid dry) " "	....	....
For concrete in the work, per cubic yard	....	....
For brick work laid, " "	....	....
For earth excavations for foundations, ℔ cu. yd.	....	....
For solid rock excavations " " "	....	....
For loose rock excavations " " "	....	....
For white oak and hard pine piles delivered per bill per lineal foot	....	....
For all other piles delivered per bill per lineal ft.	....	....
For driving piles measured in the work, including cutting and squaring, per lineal foot	....	....
For puddled earth and gravel filling in cofferdams and foundations, per cubic yard	....	....
For white oak timber and plank in work F. B. M. per *M*	....	....
For white pine timber and plank in work F. B. M. per *M*	....	....
For round oak timber in crib work, per lin. ft.	....	....

Proposals for Grading, etc.—Continued.

	$	cts.
For wrought iron work, per pound	....	....
For cast iron work per pound	....	....
For trestles complete of white oak, including iron work M. F. B., per *M*	....	....
For cross-ties, each	....	....
For rails per ton, 2,240 lbs	....	....
For cattle guards complete, each	....	....
For road crossings complete, each	....	....
For tracklaying and ballasting, per mile	....	....

General Contract.

This contract void unless approved by the President or Vice-president of the .....Railroad Company, and shall not be altered, assigned or transferred without his consent in writing.

ARTICLES OF AGREEMENT made this..... day of ....., in the year 18..., by and between ....., of the first part, and the ..... Railroad Company, by....., its chief engineer, of the second part;

WITNESSETH,—

That for and in consideration of the payments hereinafter mentioned, to be made by the said party of the second part, the said part... of the first part do... hereby covenant and agree to construct and finish, in the most substantial and workmanlike manner, to the satisfaction and acceptance of the Chief engineer of the party of the second part, and subject to all the provisions of the specifications hereunto annexed and endorsed, the work on the following sections: .....

And it is hereby mutually agreed as follows, between the parties to this contract:

[*Definitions of Terms.*]

1. Whenever the word "Contractor" is used in this agreement, it refers to and indicates the part... of the first part. Whenever the word "Corporation" or "Company" is used, the party of the second part is designated. The word "Engineer" without the prefix "Chief" refers to the engineer of the company for the time being, in charge of the work.

[*Directions, Explanations, etc.*]

2. All directions, explanations, superintendence and instructions spoken of or required under this contract will be given by the engineer or his authorized agents. The contractor may at any time require any instruction to be stated in writing.

[*Stakes and Bench Marks.*]

3. All grades, dimensions, locations and elevations of the different kinds of work will be given by proper stakes and bench marks. Such stakes and bench marks must be

preserved by the contractor until the prosecution of the work requires their removal. If the contractor willfully or carelessly removes or causes the removal of any of said stakes and bench marks before the prosecution of the work requires it, the expense of replacing them will be charged to the contractor, and the amount deducted from his final settlement.

[*Changes—How made.*]

4. The engineer may at any time make such changes in the amounts of any of the descriptions of work to be done, or the quality of the material to be used, as the interests of the work or of the company may in his opinion require. If any such changes are made after the commencement of any particular piece of work, and the cost thereof is thereby increased, the engineer shall allow such an amount as in his judgment he considers to be fair and equitable between the parties, but no claim for damages shall be made or allowed on account of any increase or diminution in the quantities of work from those exhibited at the time of letting this contract.

[*Inspection.*]

5. All materials used under this contract, of every description, and all workmanship thereon, shall at all times be open to the inspection of the engineer and of such person or persons as he may designate.

[*Measurement.*]

6. The final measurement of all work under this contract shall be made under the direction of the engineer who shall, subject to revision by and approval of the chief engineer, determine its quantity and quality, and whether it satisfies the requirements of this contract; and in case of any disagreement between the engineer and the contractor in regard to making up the final estimate, the same shall be referred to the chief engineer, and his decision shall be final and conclusive.

[*Workmen.*]

7. The contractor shall employ competent foremen and experienced mechanics, and shall promptly discharge any man or men who refuse or neglect to obey the orders of the engineer, or are considered by him to be incompetent or disorderly, and shall refuse to give employment to any who may have been discharged for such or similar cause from other parts of the work.

[*Contiguous Work.*]

8. The work herein contracted for shall, under the directions of the engineer, be so prosecuted that the progress of contiguous work shall not be delayed.

[*Detentions.*]

9. The work shall be commenced.....days after the contractor is notified that it is ready, and shall be prosecuted in such force as he shall deem adequate to insure its completion within the specified time. If after the commencement of the work, there should be any delay or hindrance to the contractor arising from any delay on the part of the company in procuring the right of way, or otherwise, he shall not on this account be entitled to claim damages, but shall be allowed such further time for the completion of the work as in the judgment of the engineer shall be an equivalent for such detentions. No allowance however shall be made while any considerable portion of the work is ready and remains unfinished, nor unless a force sufficient to complete the work within the specified time has been employed upon it from its commencement. No claim for detention on account of work not being laid out shall be allowed, unless the engineer shall have been notified in writing of the want of such work, at least three days previous to the commencement of such alleged detention.

[*Extra work.*]

10. No claims for extra work shall be made, unless the same shall be done in pursuance of a written order from the engineer at the time in charge of the work. All claims for extra work so worded and ordered must be returned to the engineer in writing within twenty days after the work was performed, and failing to make such claim within this specified time the same shall be considered as abandoned by the contractor.

[*Omissions.*]

11. Any omissions to disapprove or reject any work or materials by the engineer at the time of a monthly estimate or other estimate, shall not be considered or construed to be an acceptance of any defective work or materials.

[*Transfer.*]

12. The contractor shall not let or transfer this contract or any part of it to any persons (except for the delivery of materials) without the consent of the chief engineer, but shall give personal attention and superintendence to

the work. No sub-contract shall under any circumstances, relieve the contractor of his liabilities under this contract should a sub-contractor fail to perform the work undertaken by him.

[*Roads.*]

13. Whenever the operations of the contractor interfere with a traveled road, public or private, either by crossing said road or by making required alterations on it, he shall so conduct his work as to afford at all times a free and safe passage for travel, and shall be responsible for any damage to which the company may become lawfully liable by reason of his neglect to maintain a safe and properly protected passage way.

[*Blasting.*]

14. The blasting of rocks in the progress of the work shall be at the risk of the contractor, and all damages occasioned thereby shall be paid by him, or if paid by the company shall be charged to the contractor and deducted from any money due him under this contract.

[*Damages to Adjacent Property.*]

15. The contractor shall be responsible for all damages to land, crops, buildings fences and other property adjacent to the work by any means of his agents and servants, and for any damage to stock occasioned by the destruction of the railroad fences or from his not building new fences, and the work shall not be considered as completed until all damages of this character are settled to the satisfaction of the chief engineer.

[*Liquor.*]

16. The contractor shall not sell or give away, or permit to be sold or given away within the limits of his work, any spirituous liquors, or allow any such to be brought upon his work. He shall assist the local authorities and the officers of the company in maintaining the laws and such regulations as will conduce to the orderly and peaceable progress of all parts of the work.

[*Failure.—Forfeiture.*]

17. If at any time the contractor shall refuse or neglect to prosecute the work with a force sufficient in the opinion of the engineer to insure its completion within the time specified in this agreement. The chief engineer may direct the employment of such additional laborers and fore-

men as he may deem necessary to perform said work, at such wages as he may deem expedient to give; pay all persons so employed for their services, and charge the amount so paid to the contractor as so much money paid on this contract, or the chief engineer may at his disposal, for the failure to prosecute the work with an adequate force, for non-compliance with orders as to the manner of performing it, or for any ommisions or neglect of the requirements of this agreement and specifications on the part of the contractor, declare this contract forfeited, which declaration of forfeiture, made in writing and served upon the contractor, shall exonerate the company from any and all liabilities and obligations arising under this contract, and any balance due the contractor on account of work done shall be forfeited to the company, and the chief engineer shall have full power to enter upon and take full charge of the work and contract with any person or persons to provide for its completion.

[*Labor and Supplies.*]

18. The contractor shall be held responsible for the payment of all labor, supplies and materials furnished for any of the constructions embraced under this contract, whether such work is done directly by him or by any subcontractor under him, and in case the contractor fails to pay for such labor, supplies or materials within thirty days after payment is due, the company shall have the right to apply any funds in its hands due said contractor to the payment of such liabilities [and the amount of such payments shall be considered as a payment on this contract.

[*Time of Completion.*]

19. The entire work herein specified and contracted for shall be completed in all its parts on or before the following dates, to wit .....
.....

[*Chief Engineer's Decision Final.*]

20. The decision of the chief engineer shall be final and conclusive in any dispute which may arise between the parties to this agreement, relative to the construction or meaning of the same; and each and every person does hereby waive any right of action, suit or other remedy in law or otherwise, by virtue of said covenants, so that the decision of said chief engineer shall, in the nature of an award, be final and conclusive as to the rights and claims of said parties.

SCHEDULE OF PRICES.

	$	cts.
For clearing	....	....
For grubbing	....	....
For earth excavation	....	....
For tunnel excavation	....	....
For loose rock excavation	....	....
For solid rock excavation	....	....
For loose stone in aprons	....	....
For rip rap, cribs and elsewhere	....	....
For building board fences	....	....
For building snake or rail fence	....	....
For gates with posts and boards	....	....
For first class masonry	....	....
For second class masonry	....	....
For third class masonry	....	....
For fourth class masonry (in cement)	....	....
For fourth class masonry (laid dry)	....	....
For fifth class masonary (in cement)	....	....
For fifth class masonry (laid dry)	....	....
For concrete in the work	....	....
For brick work laid	....	....
For earth excavations for foundations	....	....
For solid rock excavations for foundations	....	....
For loose rock excavations for foundations	....	....
For white oak and white pine piles delivered	....	....
For all other piles delivered	....	....
For piles measured in the work	....	....
For puddled earth and gravel filling in coffer dams and foundations	....	....
For white oak timber and plank in work	....	....
For white pine timber and plank in work	....	....
For round oak timber in crib work	....	....
For wrought iron per pound	....	....
For cast iron per pound	....	....
For trestles complete. F. B. M	....	....
For cross ties each	....	....
For rails per ton (2240 lbs.)	....	....
For cattle guards complete each	....	....
For road crossings complete each	....	....
For tracklaying and ballasting per mile	....	....

Contractors, ...

The .....Railroad Company,

By....., *Chief Engineer.*

Approved ....., *President* (or) *Vice President.*

[*Payments, how made.—Estimates.*]

The foregoing payments shall be made in the following manner: that is to say, during the progress of the work, and until it is completed, there shall be a monthly estimate made by the aforesaid engineer of the quantity, character, and value of the work done during the month, or since the last monthly estimate, to be made by actual measurement or simple estimate, or both combined, as by said engineer may be deemed expedient, four-fifths of which value shall be paid to said part.. of the first part, at such places as the chief engineer may appoint; but it is expressly agreed that the amounts of the said monthly estimates shall in no wise be deemed payable (except as determined by the chief engineer), nor shall the same be in any manner assignable or transferable, either by the act of the part.. of the first part, or by operation of law as a subsisting debt or liability of the part.. of the second part, until the final estimate shall have been made and become payable as hereinafter provided; and when the said work is completed, and so accepted by the said chief engineer, there shall be a final estimate made by the engineer of the quantity, character, and value of said work, agreeably to the terms of this agreement, when the balance appearing to be due to the said part.. of the first part shall be paid to ....., upon .....giving a release under seal to the said company from all claims or demands whatsoever growing in any manner out of this agreement. And it is further agreed between the parties hereto, that said monthly and final estimates shall not be payable, and said part.. of the first part shall not be entitled to receive any portion of the said estimates, until said part.. of the first part shall have paid in full all persons and laborers and sub-contractors in the employ of said part..in said work, for all work and labor done up to and including the date for which the preceeding estimate or estimates may have been made, and shall give evidence of such payment by filing with the chief engineer or engineer in charge the pay-rolls for said laborers or persons, receipted in full by the same. And it is further agreed that the chief engineer shall have the right at any time, if he sees fit, of paying said laborers and persons the amounts due them by said part.. of the first part, and deducting the sums so paid from the amounts payable under said estimates. And it is expressly understood that the monthly and final estimates of said engineer, as to the quantity, character and value of the work, shall be conclusive between the parties to this contract; the former for the time being and the latter for all time, without further recourse or appeal (the monthly estimates of

the engineer being, however, subject to correction by him in any subsequent monthly, or in his final estimate, for the reason that the monthly or current estimates, being merely made out as a basis for payment on account, will necessarily be only approximately correct, pains being taken, however, to make them as accurate as possible); unless the chief engineer may deem it proper at any time to revise and alter the monthly or final estimate of said engineer, in which event the estimate of the said chief engineer shall be substituted to all intents and purposes in place of the estimate of said engineer, and shall be final and conclusive on the parties without further recourse or appeal; it being, however, wholly optional with the said chief engineer to exercise such power of revision or not.

[*Extra Work.*]

And it is further covenanted and agreed that all extra work required, and not embraced under the items and prices above set out, shall be done by the contractor at the estimates of the engineer, and said engineer shall embody in each monthy estimate a bill for the same, made out as correctly as possible for the month preceding; these bills shall be final for such months, and the acceptance of the estimate by the said contractor shall be deemed and taken as waiving any further claims for or on account of extra work done up to that time; said bills being subject to revision by the chief engineer as provided in the case of the estimate, and when so revised to be final and conclusive as above provided.

[*Additional Work.*]

And the said part.. of the first part, hereby further agree ....with the said company, that should they determine to build bridges, culverts, walls or other masonry, or do other work not hereinbefore enumerated, on the said section or sections, that the said part..of the first part will perform, build and complete the same, as though said work had been enumerated in this agreement, and for the prices hereinbefore stipulated to be paid for similar kinds of work, and upon the same terms and conditions, except with regard to the time of completing the same, which it is hereby agreed shall be extended at the discretion of the chief engineer, when the limit fixed by him shall have the same effect as though it were inserted in this agreement.

NOW THIS AGREEMENT WITNESSETH, That the said part.. of the first part, do.. hereby promise and agree to and with the said company, that..he..the said part.. of the first part, shall and will construct and complete in the manner aforesaid, the work of the.....Railroad aforesaid, on or before the first day of..... eighteen hundred and.....

[*Commencement of Work.*]

It is further agreed and understood, that the work embraced in this contract shall be commenced within.... days from the date thereof and prosecuted with such force as the engineer or chief engineer shall deem adequate to its completion within the time specified in this agreement.

[*Lack of Progress of Work.—Notice.—Manner of Survey.*]

And it is hereby further agreed, that in case the said party of the first part shall not, in the judgment of the chief engineer, well and truly from time to time comply with and perform all the terms and provisions herein stated, and stipulated in manner and form, and within the time hereinbefore mentioned; or in case it should appear to said chief engineer that the work does not progress with sufficient speed; or in case of interference with said work by legal proceedings instituted against the said part.. of the first part by other parties than the said company, the said chief engineer shall have power to annul this contract, if he sees fit so to do, by serving a notice in writing upon the said part..of the first part, or by posting such notice upon the door of his usual boarding house, on or near the work, if he is absent therefrom; when, upon such serving of said notice, this agreement and every part thereof shall become null and void, and the unpaid part of the value of the work done shall be forfeited by the said part.. of the first part to the use of said company, in the nature of liquidated damages. All right of occupancy in or upon any lands or property of the railway, and all the rights whatever of the said part..of the first part in and to any further prosecution of or interest in the work, shall forthwith cease and determine at the notice aforesaid; and the said part.. of the second part may contract anew for the work remaining to be done, or may employ any other person or persons to do and complete the work herein mentioned, or so much of it as may remain unfinished, as though this contract had never been made.

[*Notice of Suspension.*]

And it is expressly agreed, that the said company shall at any time have the right, without fault on the part of the part.. of the first part, and for any reason whatever that may appear sufficient to said company, upon giving..... days' notice thereof to the part.. of the first part, to suspend the execution of, or annul the contract; in which event, the said part..of the first part shall be entitled to the full amount of the estimate for the work done by.....up to the time of such suspension or annulment without the deduction hereinbefore mentioned; and such suspension or annulment shall not give to the said part.. of the first part any claim for damages against the said company.

[*Time.*]

It is hereby expressly agreed that the time herein stipulated shall be considered as the essence of this agreement.

GENERAL CONDITIONS.

APPLICABLE TO ALL WORK UNDER THIS CONTRACT.

[*Liquor.*]

1. The use of ardent spirits upon the work or in the boarding houses or other tenements occupied by the contractors and his men or assistants, being strictly forbidden, the contractor upon the requisition of the engineer or chief engineer, shall discharge anyone under his control who uses them or is instrumental in their use by any person employed thereon or connected with the work.

[*Discipline.*]

2. Strict discipline and order among the workmen both while on or off the line must be enforced by the contractor, who shall discharge from the work any person in his employ, upon the requisition of the chief engineer, and be responsible for all damages to persons or property caused by any person or animal in his employment; and the chief engineer is authorized to withhold the estimate until satisfaction for the same has been made.

[*Transfer of Contract.*]

3. The contractor shall not let or transfer his contract or any part of it without the written consent of the chief engineer.

[*Defective Work.*]

4. The contractor, upon being so directed by the engineer or chief engineer, shall remove and rebuild or make good without charge, any work which any of them may consider defectively executed.

[*Authority of Engineer, etc.*]

5. The contractor shall commence, prosecute and complete the work in all its parts under the directions of the engineer, who shall have power to direct the application of the force to any portion or portions thereof he may indicate, to change the point of beginning and ending of section, and to order the increase or diminish the amount of said force at his pleasure. Should the right-of-way not be procured at any place when the contractor desires to work thereon, he shall distribute his forces to such other points as may be designated by the engineer, without any claim for damages for failure to procure such right-of-way. The chief engineer shall make such allowances and estimates as he deems just, for any loss or damage to the contractor resulting from delays of any kind, whether caused by failure to procure right-of-way, borrow-pits, or materials required to be procured by the company or to furnish plans, or from alterations in plans, or from any other cause whatever; and it is expressly understood that the contractor agrees to accept such allowances and estimates in full satisfaction of such loss or damage, the decision of the chief engineer as to amount of such loss and damage being final and conclusive, and binding on both parties.

[*Personal Supervision.*]

6. Nothing short of absolute assignment of this contract, with the consent thereto of the chief engineer written upon these articles of agreement, shall release the contractor from the duty of giving his personal superintendence to the work, or discharge him from responsibility for its execution according to the contract.

[*Wages of Labor.*]

7. The chief engineer shall have the right to regulate from time to time, the wages of labor upon the line of work, having due regard to prevailing rates, with the sole view to maintain a proper distribution of the forces, and prevent the injurious effects of competition among the contractors for hands, this regulation being intended as much for their benefit as for that of the railway company.

[*Verbal Agreement.*]

8. This contract shall be in nowise affected by verbal agreements, or inferences from conversation previous to or subsequent to its execution.

[*Alterations and Amendments.*]

9. All alterations, amendments or modifications of this contract in any particular whatever, must be in writing, and called a supplement, which shall have proper reference to the contract by date and description of work, and be duly signed, in which supplement shall be fully described the particular work to be affected by such alteration, amendment or modification.

[*Final Estimates.*]

10. The widths and slopes of excavation and embankment established by the chief engineer, in connection with the elevation of ground as shown by the level notes taken during the location of the line, shall be considered sufficient data for making up the final estimate, if the chief engineer may so determine, who may also decide what average slope of the surface of ground on cross-section shall be adopted.

SPECIFICATIONS

FOR CLEARING, CLOSE CUTTING, GRUBBING, GRADING;

EARTH, LOOSE AND SOLID ROCK EXCAVATING; TUNNELING, MASONRY (1st, 2d, 3d, 4th & 5th CLASS), FOUNDATION, STONE, CEMENT, SAND, MORTAR, CONCRETE, TIMBER WORK, COFFER DAMS, PILING, PILE AND TRESTLE BRIDGES, FENCING, GATES, TRACKLAYING, BALLASTING, TIES AND RAILS.

Clearing, Close Cutting and Grubbing.

[*Clearing.*]

When the line passes through wooded sections the land must be cleared to the full width of..... feet (being ....feet on each side of the center line), of all timber, trees, brush, bushes, fences, brush-logs, etc. The valuable timber to be preserved as may be directed by the engineer, the rest to be burned when it can safely be done, otherwise to be piled up outside the slope stakes of excavations, embankments and borrow-pits, as may be directed by the engineer. In no case is the brush, stumps, logs, etc., to be carried into embankments or thrown back on adjacent lands. In clearing, great care must be taken to preserve center and slope stakes.

[*Close Cutting and Grubbing.*]

When embankments are formed less than three feet or more than one foot in height all the standing timber and stumps must be chopped close to the ground within the limits of the embankments. When the embankments are less than one foot in depth, all stumps and large roots are to be grubbed out, piled and burned when safe to do so.

Specifications for Grading, etc.

[*Grading.*]

1. Under the head of Grading will be included all ditching and draining, and all excavations and embankments required for the formation of the road-bed, or in any way connected with, or incident to the construction of the same.

[*Width.*]

2. The road will be graded for a single track, except when otherwise directed by the chief engineer, and in conformity with such breadths, depths and slopes of cutting and filling as he may determine.

[*Excavation, Earth, Loose Rock, Solid Rock.*]

3. The excavations will be divided into three kinds, viz.: Earth, loose rock and solid rock. Under the head of earth will be included clay, sand, gravel, loam, hardpan and all other matters of an earthy kind, however hard, stiff or compact, and all bowlders containing less than three cubic feet each. Under the name of loose rock will be included all stone and detached rock found in separate masses containing not less than three cubic feet nor more than one cubic yard; also, all slate or other rock, soft or loose enough to be removed without blasting, although blasting may be occasionally resorted to. By solid rock will be understood all rock found in masses containing upwards of one cubic yard, and which can be only removed by blasting. The bids will be made separately for each kind of material as just described.

[*Tunneling.*]

4. Tunneling will include all materials of whatsoever kind found within the limits of the section prescribed for the tunnels by the engineer, the area of which shall not be less than....square yards, and of such forms and dimensions as the said engineer may direct. The tunnels will be carefully cut out to the lines of the sections prescribed by the engineer, and the cost of supporting the roof and sides, where timber propping is required, during the progress of the work and until its completion, shall be borne by the contractor without extra compensation. For all material that may fall, or be removed in anticipation of falling, from the roof and sides of the tunnels, outside of the section established by the engineer, such price shall be paid the contractor as the

chief engineer may fix; and for all that may be left unexcavated within said sections, such deductions shall be made as he may determine. The width, height and general figure of sections of tunnels, as well as the mode of supporting the roof and sides, will be varied by the engineer as the circumstances of each particular case may seem to require. If, in the judgment of the chief engineer the tunnels shall require to be arched, in whole or in part, with bricks or stone masonry during the progress of their excavation, the party of the first part shall do the necessary arching, and also construct the masonry of the portals or facades, if called upon to do so by the engineer, at the price hereinbefore named. If shafts for ventilation, drainage, or the removal of material are required, they shall be excavated of the form and size and in the position indicated by the engineer, whose directions in relation to the mode of supporting the insecure portions of the shaft by cribbing will be strictly adhered to, the expense of such cribbing being borne by the party of the first part.

[*Ditches.*]

5. Such ditches shall be dug within or without the limits of the road as the engineer may direct.

[*Waste.*]

6. Materials necessarily wasted from the cuttings shall be deposited in the vicinity of the road, according to the directions of the engineer.

[*Borrow.*]

7. Materials required for embankment, and not supplied by the excavations within the line of the road, shall be obtained from the places and in the manner directed by the engineer.

[*Water-courses.*]

8. The road shall be secured against damage from all water-courses in the vicinity thereof, or in contact therewith, by building or facing the embankment with stone, or by widening the existing or excavating new channels, or in such other manner as the engineer may direct.

[*Roads and Highways.*]

9. Commodious passing places for all public and private roads, crossing or in contact with, or adjacent to said railroad, shall be opened and kept in good condition; and sufficient fences shall be provided and maintained for the preservation of all growing crops by the contractor at his expense.

[*Materials for Ballast.*]

10. The contractor, when directed by the engineer, shall lay aside for ballast for the rail tracks in such places as may be pointed out, any excavated rock or stone, allowance being made, according to the judgment of said engineer, for such material as may be required to supply any deficiency in the embankment thereby occasioned.

[*Distribution.*]

11. The distribution of materials directed by the engineer, must be strictly adhered to.

[*Excavation, Nature of.*]

12. The price of excavation is intended to pay for removal of all materials found within the limits and above the grade of the road, or taken from new channels cut for streams, or from ground excavated for roads, or from borrow-pits, drains, ditches, canals or from any points within or without the limits of the road for the purpose of making any embankment, or obtaining embankment for other purposes outside of said limits, with an average haul of not more than 300 feet to place of deposit; there being no compensation for embankment, it being necessarily made by the excavation.

[*Measurements.—Shrinkage.*]

13. All material will be measured before or after its removal, as the engineer may elect. All embankments shall be made in layers of such thickness as the engineer may prescribe; and, in completing them, such additional quantity of material shall be placed in them as the engineer may think necessary and may direct as allowance for shrinkage, so that after the shrinkage shall have taken place the embankment will be at grade and of specified dimensions, by which dimensions the quantities are to be ascertained for payment; the contractor not being allowed for such additional material required to provide for or make up such shrinkage where the engineer elects to measure after removal.

[*Beam.*]

14. The width of the beam shall be the height of the embankment or depth of the cutting, directly opposite, unless otherwise directed by the engineer.

[*Falls and Slides.*]

15. All falls or slides from the roofs or sides of tunnels or open cuttings shall be paid for at the prices of the mate-

rial which they most nearly resemble in the judgment of the chief engineer.

[*Materials Taken.*]

16. Persons contracting with the company for any other work, shall be permitted to take materials of any kind wanted for said work, from the part of the road designated, and to haul them over the same; said persons alone, and not the company, being responsible for any damage the removal of said materials may occasion to the parties engaged in graduating said part of the road.

[*Horseback Road.*]

17. The contractor, before commencing work, and immediately after signing his contract, if required by the engineer, shall open and maintain a good, safe road for passage on horseback through the whole length of his work.

Specifications for Masonry.

The work will be divided into sections, as shown upon the profiles, and will consist of such structures as, in the opinion of the engineer, are necessary or desirable.

[*Quantities.*]

The quantities of work done shall be estimated from the plans of the structures The quantities exhibited in the schedules are approximate only, and may be varied in part or wholly changed during the progress of the work, and no claims arising from misconception of the quantities or kinds of work, or errors in the approximate estimates of quantities, are to be allowed or entertained.

[*Excavations and Foundations.*]

All excavations for, and the foundations of all structures herein contemplated and referred to, shall be made and paid for as described and provided in the annexed specifications for foundations and timber work.

[*Masonry Classification.*]

Masonry will be paid for by the cubic yard, and will be classified as first, second, third, fourth and fifth class. First and second-class masonry shall be built of sound, durable limestone or sandstone. The remaining classes of good quarry-stone, approved by the engineer.

[*How Estimated.*]

First and second-class masonry will be estimated by measuring each block of stone before it is laid in the structure. The price will include the cost of laying. All other classes will be estimated from the plans of the completed structure; any first and second-class masonry included being deducted from the total amount.

[*First-class Masonry.*]

First-class masonry will consist of dimension-stone, and will generally be used in large arches and for bridge seats, and coping of the more important structures. Each stone shall have beds and joints, well bush-hammered, and cut true to the square, and shall be laid in the work so as to form a quarter-inch joint throughout, and breaking joints in adjacent courses at least one foot.

Arch-stones shall have beds to conform to the radii of

the arch, with end joints vertical. Each stone must extend through the whole thickness of the arch, and be not less than eight inches wide on the intrados. Coping will be from eight to sixteen inches thick, as may be required. The face of all stone in first-class masonry will be bush-hammered or rock faced, with one-inch draft as may be directed. The backing of first-class masonry will be estimated as fourth-class masonry.

[*Second-class Masonry.*]

Second-class masonry will consist of ashlar work, and will generally be used for the face of abutments, piers, parapets and wing walls in large structures. Each stone to be rock-faced with edges pitched to straight lines, and no projections exceeding two inches. Beds to be bush-hammered for sixteen inches back from the face, and end joints for ten inches back. Stones to be laid on their natural beds in regular courses, with one header to every two stretchers, and bonding not less than twelve inches with contiguous courses. No header to be less than four feet long, and no stretcher to be less than eighteen inches wide, no stone to be less than ten inches in thickness, or to have a greater height than width. The whole to be set level, well bedded in mortar, and laid to a quarter-inch joint. The backing to be of large sized stone, laid in courses corresponding with the face stone; but two courses may fill up one of the face, provided that no stone less than six inches thick is used. The broadest bed to be laid undermost, and to have a good bearing on the stone below. Two-thirds of the upper bed to be of full thickness of course. The backing of second-class masonry will be estimated as fourth-class masonry.

[*Third-class Masonry.*]

Third-class masonry will be used in small arches, and will consist of selected flat rubble stone from four to eight inches thick, and extending the whole depth of the arch. The stone to be well bonded and to be kept radial by "chinking" on the outside of the arch, and driving close with a mallet. The whole to be well bedded in mortar and grouted. The exterior of all arches shall be plastered over with a two-inch coat of cement mortar.

The centering shall be approved by the engineer, and shall not be removed until he directs. The cost of plastering and centers will be included in the price for masonry.

[*Fourth-class Masonry.*]

Fourth-class masonry will be used in the abutments of small bridges and arch culverts, and in box culverts and

cattle-guards, and for backing of first and second-class masonry. It shall consist of good quarry-stone, laid on their natural beds, and roughly squared when used for face work. The walls shall be carried up in courses from fifteen to eighteen inches thick, and shall be well bonded, having one header to every three stretchers. Not more than one-third of the stones shall be less than nine inches thick, or contain less than two cubic feet, and no stone shall be less than six inches thick. The whole shall be laid in cement mortar, and grouted every course, or dry, as the engineer may direct.

The foundation course shall consist of large, flat stones, not less than ten inches thick, and extending through the wall when the width is less than four feet. The covering stone for box culverts shall be not less than ten inches thick for two feet culverts, twelve inches for three feet culverts, and fifteen inches for four feet culverts, and shall rest firmly upon the side walls for not less than twelve inches. A rubble arch may be substituted in case stone suitable for covering cannot be obtained.

[*Fifth-class Masonry.*]

Fifth-class masonry will be used in retaining walls and pavements. It shall consist of stones not less than three inches thick and one cubic foot solid contents, laid and bonded to give the greatest degree of strength, and with the beds perpendicular to the face when required. Where paving is required, the earth shall be excavated to the depth directed by the engineer, and the space so excavated shall be filled with gravel or sand as a foundation for the paving, which shall be made of flat stones, one foot wide, set on edge, close laid and rammed to an even surface. The spaces shall be filled with sand, and grouted if required. Fifth class masonry will be laid dry or in cement, as the engineer may direct.

[*Stone.*]

All stone used in masonry must be sound, durable, of good shape, of suitable dimensions and of quality approved by the engineer.

[*Laying Stone.*]

Not more than two unfinished courses shall be allowed at one time in any wall, and as a rule, one course must be completely finished before another is begun. No stone once bedded must be removed, unless directed by the engineer for the purpose of inspection.

[*Cement.*]

Cement shall be the best quality, hydraulic, newly manufactured, well packed and protected until required for use. None to be used until accepted by the engineer. Any cement condemned by him must be immediately removed from the work.

[*Sand.*]

All sand used in mortar must be sharp and clean, and free from loam and vegetable matter. If sand of such quality cannot be found in natural beds, it must be obtained by washing and screening.

[*Cement Mortar.*]

The general proportions of sand and cement for mortar will be two of sand and one of cement. It shall be used immediately after mixing and any that has been mixed for more than half an hour, or has commenced to set, shall be rejected and thrown away. Each course of masonry when laid, shall be thoroughly grouted with thin mortar of same quality as above.

[*Pointing.*]

All outside joints of first and second-class masonry will be raked out to a depth of one inch and neatly pointed.

[*Concrete.*]

Concrete will consist of fresh ground cement, clean, sharp sand, and stone or brick broken to pass through a two and one-half inch ring. The cement and sand shall be mixed as required for cement mortar, and then mixed with the broken stone or brick, in the proportion of one of mortar to two of broken stone, immediately before using. When put in place it will be at once leveled off and tamped, but must not be touched afterwards.

[*Brickwork.*]

When brick are required, or allowed to be used, they shall be sound and hard burned, and laid in cement mortar.

No soft, medium or swelled brick will be used, and all brickwork must be built by skillful workmen. The bricks must be thoroughly saturated with water before being used. Brickwork will be paid for by the thousand in the work, estimating twenty-two and one-half bricks to the cubic foot.

[*Scaffolding.*]

All scaffolding required in the construction of masonry will be furnished by the contractor without any extra charge.

The quality of the masonry in any particular structure will be directed by the engineer.

For a more full and perfect explanation of the form and dimensions of any structure, plans will be furnished by the engineer, and such directions be given by him during the progress of the work as may appear to him necessary and proper, in order to make the work in every respect perfect and complete as contemplated in these specifications, and the said plans and directions shall be in all cases followed out and complied with.

Specifications for Foundations and Timber Work.

DESCRIBING THE METHOD OF PREPARING FOUNDATIONS FOR STONE AND OTHER STRUCTURES, AND OF CONSTRUCTING PILE AND TRESTLE BRIDGES AND DOCKS.

[*Excavation.*]

All excavations required for the work herein contemplated shall be made as directed by the engineer. The materials excavated shall be measured in excavation only, and shall be classified under the heads of solid rock, loose rock or earth, as it may be.

[*Coffer-dams.*]

Whenever, in the opinion of the engineer, coffer-dams are required for the proper execution of any work herein contemplated, the contractor shall provide all necessary materials, and construct the same in accordance with the plans and directions of the engineer. And when their use is no longer required, they shall be removed without any additional charge for removal.

[*Bailing, etc.*]

All bailing, pumping, etc., incident to the work, shall be done by the contractor, and the price specified in the schedule of prices shall be full compensation therefor.

[*Foundation Pits.*]

Foundation pits shall be excavated to the depth required by the engineer, and shall be made smooth and even at the bottom to receive the foundation, whether of stone, concrete or timber.

[*Foundations.*]

If earth of sufficient firmness to build upon cannot be obtained at a reasonable depth, foundations of timber, or timber and piling, shall be constructed as may be provided.

[*Piling.*]

Piling may be used in constructing coffer-dams, for bearing piles in foundations, for protecting earth slopes from sliding or undermining, and for pile bridges.

[*Piles Delivered.*]

Piles delivered will be paid for by the lineal foot as per bills given by the engineer.

[*Piles Driven.*]

Piles driven will be paid for by the lineal foot, measured in the work, from the top of the pile when cut off. The price will include pointing and cutting and tennoning.

Piles for pile bridges and for protecting slopes shall be of white oak or hard pine. For bearing piles and other purposes, except as above, they may be of spruce or any other timber approved by the engineer. All piles shall be delivered according to bills furnished by the engineer; and shall be of round timber not less than eight inches in diameter at small end, straight, free from rot, large knots and other imperfections, barked, accurately pointed, and properly banded at the head to prevent splitting or brooming while being driven. When required by the engineer, the points shall be shod with a wrought or cast iron shoe, to be furnished by the contractor at cost.

Piles shall be driven in such places and to such depths as the engineer may require. The heads of bearing piles must be cut off square so far below low-water level that any timber foundations laid thereon shall be at all times entirely immersed. In pile bridges the heads shall be finished smooth and square to receive cap or sill.

Timber and plank foundations shall be made from sound hemlock or other timber approved by the engineer, and in strict accordance with the plans furnished. Where such foundations are supported upon bearing piles, the timbers shall rest closely and be secured to each pile by a rag-bolt one inch square and twenty inches long.

Where no piles are used the timbers shall be evenly spaced, and in number sufficient to cover at least two-thirds the area of the foundation. In all cases the spaces between the timbers shall be filled in with gravel, well rammed and puddled. The covering plank shall be well spiked to each timber.

[*Sheet Piling.*]

When required, sheet piling of hemlock plank, of lengths directed by the engineer, shall be used to protect foundations and elsewhere. Ditches shall be excavated to receive the sheet piling, which are to be placed edge to edge, and well spiked to the foundation timbers at the top, and faced with one-inch hemlock boards nailed to the piling. The ditches shall then be filled in with gravel, well rammed and puddled.

[*Pile and Trestle Bridges.*]

Pile and trestle bridges shall be made in all respects according to the plans and bills of timber and iron fur-

nished by the engineer. The timber to be of white pine and white oak, sound, free from wane, loose knots and other imperfections, and sawed straight and square. The several pieces to be accurately framed and fitted, and put together with all necessary bolts and washers. The stringers of pile and trestle bridges will be of first quality white pine, and will be used in pairs so arranged as to break joints on each bent. The maximum dimensions of stringers will be seven by fourteen inches by thirty-two feet.

[*Crib Work.*]

Foundations of crib work shall be built when required; to be made of sound hemlock timber, twelve by twelve inches square, and of any required length up to thirty feet. The side and end timbers to be halved together at the corners. The side timbers to be fastened together by cross ties every eight feet, and framed with a dovetailed joint. The ties in one course to be intermediate with those in contiguous courses, and each course to be secured to the preceding course by rag-bolts one inch square and twenty-two inches long.

The first or second course of timber, as may be directed, shall be covered with ten by twelve timbers, laid close together crosswise, as a bottom to the crib.

The site to be leveled off so as to give a uniform bearing to the crib, which shall be carefully filled with loose stones, and when required, shall be covered across the top with hemlock timbers ten inches thick, laid in such manner as to cover the whole surface, and each timber to be rag-bolted to the sides of the crib.

When required, bearing piles may be driven to support the foundation, the same to be enclosed by a crib built as above described.

[*Docking.*]

Timber docking shall be built in such places as the engineer may direct. The face timbers to be of sound pine or hemlock ten by twelve inches, laid on the ten inch face, and rag bolted together every four feet in length, with three-fourths inch square bolts twenty inches long. The cross ties to be of round oak or chestnut twelve feet long, and not less than four inches in diameter at small end, dovetailed into face timbers, placed six feet apart, breaking distances in alternate courses, and anchored by notching and spiking, to round sticks of chestnut or white oak not less than eight inches in diameter, laid parallel to front timbers, and ten feet back.

Puddled earth in coffer-dams, and all excavation, gravel filling and loose stone filling required in the construction of foundations and timber work, will be paid for at the specified prices per cubic yard. Wrought and cast iron will be paid for at the specified prices per pound. Timber will be paid for at the specified prices per thousand feet board measure, and the prices for timber shall include the cost of labor required to place the same in the work as contemplated and provided for in these specifications.

The engineer may reject any materials delivered for piling and timber work, which in his opinion are unsuitable, and materials so rejected shall be immediately removed from the work.

For a more full and perfect explanation of the form and dimensions of any structure, plans will be furnished by the engineer; and such directions will be given by him during the progress of the work as may appear to him necessary and proper in order to make the work in every respect perfect and complete, as contemplated in these specifications, and the said plans and directions shall be in all cases followed and complied with.

Specifications for Fencing.

Fences shall be built upon the company's land, at such points as the engineer may direct.

[*Removing and Rebuilding Old Fences.*]

Whenever it is necessary to move an existing fence, and the materials composing it are, in the opinion of the engineer, suitable for further use, the new fence, whether of wood or stone, shall, to the extent directed by the engineer, be made from the old materials, which are to be carefully removed and reconstructed in a thorough and substantial manner.

[*Stone Fences.*]

All stone fences will be built in the strongest and best manner. The stones must be well bonded and a suitable proportion of headers must be used. The wall will be two and one-half feet wide at the bottom, one foot wide on top, and four feet high.

[*Post and Board Fences.*]

Post and board fences will be made as follows: Posts shall be of white oak, cedar or chestnut, eight feet long, not less than six inches in diameter at small end, flattened on one side, and hewn out of wind to receive the boards; they shall be set in the ground three feet, and be not to exceed eight feet apart; the earth shall be well packed and tamped around them.

Each panel of fence shall consist of four boards of sound pine, spruce or hemlock, not less than one inch thick. The boards shall abut end to end squarely, and shall meet in the center of the posts. The bottom board shall be ten inches wide, and the three upper boards eight inches wide. The bottom board shall be four inches from the ground; the space between the bottom and the second board shall be four inches, between the second and third boards, five inches, and between the third and top board seven inches, making a fence four and one-half feet high. The bottom board shall be nailed to each post with three tenpenny nails, and the remaining boards with two tenpenny nails to each post. The posts shall be sawed off evenly with the top of the upper board, and battens six inches wide and four and one-half feet long shall be nailed over the boards at each post with eight cut nails four and

one-half inches long, driven through both batten and fence boards into the post.

In constructing the fence the lower board shall conform to the general surface of the ground, and all the boards of a panel shall be parallel. Holes under the bottom boards that will admit small animals, must be stopped up.

In cases where post holes cannot be sunk into the ground, a foot log six by six and four feet six inches long with a diagonal stay four by six mortised into the foot and the posts may be substituted. The foot of the post being mortised into it and standing four feet six inches high from the bottom of the foot.

[*Snake Fencing.*]

The snake fence shall consist of straight split oak or chestnut rails, not less than four inches at the small end, thirteen to fifteen feet long; angles at intersection of panels, three feet.

Fence to be five feet high, and to be in accordance with any local regulation that may be in existence. Before laying the last rail, stakes shall be driven at right angles to the panels, on an angle crossed at the top, and the last rail laid to form a rider.

In cases where stakes cannot be driven into the ground, the stakes are to be driven into a foot log, with a two inch hole bored to receive them.

[*Gates.*]

Gates for the accommodation of adjacent land owners shall be placed where directed. Gates will be paid for separately, and the price will include the gate posts and the hangings and fastenings complete. The posts will be of white oak, cedar or chestnut not less than ten inches square, and shall be set three and one-half feet deep in the ground. The gates shall be made according to plan furnished, and to be strongly framed and put together, and fitted with approved hangings and fastenings.

Fences shall be connected with all cross fences, and with cattle guards and other structures when required.

Specifications for Tracklaying and Ballasting Tracks.

The road will be divided into divisions, comprising one or more of the residencies worked by the several contractors, for grading, masonry, etc.

[*Tracklaying.*]

All materials for the track will be furnished by the company, and will be distributed along the line adjacent to the work. The company reserve the right to lay such portions of the track as the chief engineer may deem expedient. All track laid by the contractor must conform strictly to the following conditions:

The cross ties will be laid at right angles to the line of the track on tangents and radially on curves, and shall be placed so as to afford a bearing surface equivalent to one-third the length of the track. With ties of a uniform face of eight inches, 2,640 would be required for each mile. The broadest ties shall be placed under the joints; the ties next to the joint ties shall be of equal width and shall be laid equidistant from the joint. All ties shall be placed so that their centers will be in the middle of the track.

The rails on straight lines will be so selected and laid that the joints of parallel rails will be within two inches of being opposite to each other. On curves the rails must be bent to pressure to conform to the curvature, and the difference in length will be overcome by using short rails as frequently as may be found necessary, the outside rail to be at the elevation directed by the engineer. In case rails have to be cut, new holes must be drilled to secure the fish-plates and bolts. In laying the rails allowance must be made for expansion by inserting slips of metal between the ends of the bars. The thickness of these slips will vary with the temperature at the time of laying the track. The rails will be connected by joints, such as may be selected. Each nut must be screwed home with a wrench three feet long. Four spikes will be driven in each tie—one on each side of each rail. Care must be taken to drive the spikes as nearly perpendicular as possible and to keep the track gauge uniformly at right angles to the rail.

The clipping or abrasure of the rail by careless spiking will be followed by the discharge of the workman.

When the track is approaching cattle guards or bridges, rails of such lengths must be selected that a joint will not

come on the stringer outside of the face of the wall. The same precaution will be taken to avoid joints on the portion of road crossings that will be covered with planking. Sawed ties will be used for all bridges, open culverts and cattle-guards. They will be boxed down about one inch upon the stringers, the top surface being brought to a true plane. The contractor shall lay such permanent turnouts, sidings and switches as the chief engineer may require. The frogs, switches, switch-posts, etc., shall be properly placed and securely fastened, and left in perfect working order. Sawed timbers of various lengths will be used from the mouth of the switch to the heel of the frog. The guard-rails must be properly bent and secured in place by chairs and spikes.

Tracklaying will be paid for by the mile of single track laid. In measuring sidings the distance shall be taken from mouth to mouth of switch. In addition to the price per mile, an extra allowance of ..... dollars will be paid for each complete switch and frog laid in the track.

The above provisions apply only to permanent track. All temporary tracks for the use of the contractor in gravel-pits or otherwise will be laid by him at his own cost, the company furnishing the materials for the same, delivered convenient to the work. The contractor will be held accountable for the proper use in the work of all materials furnished him, and must make good any waste of spikes, bolts, etc., arising from the negligence of his employes.

[*Ballasting.*]

Ballasting will include the loading, transportation and distribution of the ballast.

The ballast will be measured in the several pits, and paid for by the cubic yard. The price per yard will cover the transportation and distribution of the ballast. The amount required will be about 3,000 cubic yards per mile of the track, or at such depth or width as the engineer may direct. The work of ballasting will generally be commenced at the several gravel-pits, and the track must be put in order as the work progresses, and maintained so that the rails will not be injured. The company will furnish engine, platform cars (fifteen for each train), and the fuel, oil and waste necessary to run them, and engineman, fireman, conductor and brakeman, and shall make all ordinary repairs to the engine and cars at their own expense. The contractor shall pay the company at the rate of ..... dollars per day for the use of the engine, which shall include the fuel, oil and waste used; and at the rate of ..... dollars per day for each car so furnished, and also the wages paid by the railway company to the

engineman, fireman, conductor and brakeman; said payment to commence with the day when said engine and cars are furnished, and to continue until the engineer is notified by the contractor that they are no longer needed. All breakages of engine and cars caused by the negligence of the contractor or men in his employ, shall be paid for by the contractor. When it is in the pit or on the track it shall be operated according to the wishes and directions of the contractor, but shall be subject at all times to the rules of the road.

In loading ballast, all roots, stumps, sods and bowlders must be left in the pit and deposited on the outside of the loading track. None shall be distributed along the road-bed. When this rule is neglected by the contractor, his work will not be estimated and paid for until he has removed from the road-bed all such material so deposited.

Whenever it becomes necessary to remove from the pit any materials which are not suitable for ballast, such material shall be used to widen embankments for sidings at such points within the limits of the contract as the chief engineer may direct. All materials so deposited shall be leveled off to the sub-grade line.

In unloading ballast, especial care must be taken to deposit it upon the road bed, and that none shall be wasted upon the slopes of the embankments or in the side ditches.

Surface Drains, and Road and Farm Crossings.

Surface drains to carry the water across the tracks, shall be placed as may be directed. They shall be eight inches square inside and ten feet long, and shall be made of two and one-half inch hemlock plank. The sides shall be kept apart at the top by two pieces of boards properly nailed on.

At all road and farm crossings the tracks shall be kept in order for the passage of teams, etc., at all times during the progress of the work. As fast as the surfacing is completed the crossing-plank will be securely spiked to the ties, and the approaches will be filled up and leveled. The hemlock used in constructing drains, and for road and farm crossings, will be furnished by the contractor and will be paid for by the 1,000 feet, B. M., in the work. The price will include the spike and all labor incident to the work.

General Conditions.

The company engage to furnish the contractor all reasonable facilities for the performance of his work; but the same must be so conducted in all cases that the traffic of the road shall in no manner be obstructed or inconvenienced; and all the operations of the contractor must be subordinate to the full and safe use of the track for the movement of trains.

So long as the contractor continues to use any portion of the track, he shall keep the same in order, so that upon its final acceptance it shall, in all respects, conform to the requirements of these specifications.

The chief engineer will direct in what order the work shall be performed, and from time to time during its progress, either personally or through his assistants, will give such instructions in relation thereto as may seem to him expedient, and all such instructions must be fully complied with.

Cross Ties or Sleepers.

[*Ties.*]

All ties to be of good, sound tie timber of white oak, chestnut, heart pine, cypress, cedar or hackmatack, to be straight and smoothly hewn on two sides to parallel faces six inches apart, with eight-inch face and eight feet long. The bark to be taken off and ends cut square.

[*Delivery.*]

Ties to be delivered on the line of the road at convenient points to be designated by the engineer, and in such quantities as may be necessary to reach from one point of delivery to another.

ANOTHER FORM.

1. Ties must be cut from green or living white oak or chestnut timber, of good quality, free from twists, cracks, decayed knots, worm-eaten timber or unsound parts, and hewn or sawed smooth and straight on two sides, with parallel faces without deep score marks, and of even thickness, cut off square at each end and stripped of bark. Split ties, or ties sawed on more than two sides, will not be received as first-class.

2. Ties must be eight feet long, seven inches thick, and not less than eight inches wide; a variation of only one-half inch in length, and of one-quarter inch in the thickness given, will be allowed.

3. Ties must be delivered on the company's right-of-way, piled up in neat stacks, ten one way and two the other, with a space of not less than five feet between the piles, located on ground which is as high or higher than the railroad track, not less than eight feet from the nearest rail, and in such position as will enable them to be loaded easily on cars.

4. Ties will be at owner's risk until accepted by the tie inspector; and when rejected they must be removed from the premises of the company without delay, at the expense of the owner thereof.

Ties inspected and accepted up to the ..... of the month will be paid for during the following month.

Specification of .... Pound Steel Rails.

[*Section.*]

The form of the rails is to be ..... section, with such modifications as be authorized and directed by the inspector at any time.

[*Weight.*]

The rails are to weigh.....pounds per yard with the usual allowance of two per cent on single rails, and one per cent on total quantity will be accorded without objection, but the rails must not be invoiced at more than their rate per yard for the total orders, and makers will be answerable for the full weight as per invoice.

[*Length.*]

The standard length to be thirty feet, except an allowance of ten per cent to be made, such length as may be ordered by inspector, no rail to be under eighteen feet in length.

[*Drilling.*]

Drilling of rails: ..... round holes ..... at each end, the center of the first hole ..... inches from center of first hole; each rail to be notched..... × ..... at the four corners.

[*Marking.*]

Each rail must bear the name of the maker, the year in which it is rolled, and the letters must be distinct so as to identify the rails. Each rail when inspected and approved must be stamped with the private stamp of the inspecting engineer, the rails will not be accepted unless this has been complied with. The steel must be cast in ingots by the Bessemer or Siemens process, and must be of uniform quality and equal hardness throughout, and the inspecting engineer will be at liberty to test sample ingots, by forging, tempering, bending or otherwise to satisfy himself of the proper material being used. These ingots must be heated well through, then hammered or rolled into a rail with exact section.

Flaws or cracks in the ingots must be cut out before the last rolling so as to make a clean and smooth rail, free from flaws, cracks or other imperfections; no patching or mending the flanges will be allowed.

[*Inspection.*]

The rails will be passed in lots not exceeding 1,000 bars each; the engineer or inspector appointed by the company will select from each lot a certain number of rails, not exceeding one per cent of the whole, and will test them as follows:

[*Tests.*]

1. Each of the selected rails must carry ..... tons in the center, between equal bearings, five minutes without permanent set.

2. These rails must carry in some positions a load of twenty-six tons without breaking; after these the flanges of the rails will be cut and the rail broken. The fracture must show perfect welding.

3. Each half of the broken rail again placed on three foot bearings, must stand a blow from a ball weighing one ton, falling from a height of fifteen feet, on the rail between the supports, without showing any signs of fracture. The bearings are to be of cast iron fixed on oak frames, supported on solid masonry four feet deep. Should one of the rails fail under any of the above tests, the lot will be divided into three equal portions, and one rail from each will be tested. Each rail then proving unequal to the test will cause the lot from which it was taken to be rejected.

The inspector of the company is to have the right of entrance to the work at all times to inspect the manufacturing quality of the materials, and to superintend the testing of the rails, but this inspection is in no way to remove the responsibility of the manufacturer, who is bound to deliver nothing but good, sound rails, of best workmanship, and best materials.

Any remarks which the inspector may have to make, are to be addressed to the manager of the works, and not to the workmen therein employed. All rails inspected, approved and stamped by the inspecting engineer, cannot afterward be rejected.

[*Notice of Rolling.*]

The maker is to give eight days' notice to the inspecting engineer of commencing the rolling, and not less than two days' notice, after resuming the work, after temporary suspension.

On condition of the faithful fulfillment by said part .. of the first part of the foregoing agreements and provisions of this contract, as explained in the specification,—

The ..... railway company, parties of the second part, hereby promise and agree to pay or cause to be paid to the said part .. of the first part, heirs, executors, administrators, or assigns, for doing and performing the work aforesaid, the prices signed by the part.. of the first part and the chief engineer of the said company, and during the progress of said work, so long as the terms of this contract shall be complied with by the part.. of the first part, to make monthly estimates and payments to said contractors in each month for the work done in the preceding month. These estimates shall be based upon the said schedule of prices and ..... per cent of the amount thereof shall be retained by said company until the final completion of work and the acceptance thereof by the chief engineer, it being, however, expressly understood and agreed that these payments refer only to work completed, and that it will be discretionary with the company to make any payments on account of materials delivered and not permanently applied to the work, for which they may be intended.

And when the whole of the work herein contracted for shall have been finished and accepted, the balance of money due for said work shall be paid to the part.. of the first part ..... heirs, executors, administrators or assigns. And the said part.. of the first part agrees to accept the aforesaid prices in full compensation for the work herein contracted for.

In witness whereof the part.. of the first part and the chief engineer of the party of the second part hereunto subscribe their names.

.....
.....

The .....Railroad Company,
By.....Chief Engineer.
Approved,
.....President.

SPECIFICATIONS.

SECOND FORM.

CONTAINING FORM FOR CONSTRUCTION CONTRACT, PRICES AND GENERAL CONDITIONS.

SPECIFICATIONS FOR

CLEARING — GRUBBING — GRADING — MASONRY — FOUNDATION AND TIMBER WORK.

[SECOND FORM.]

Construction Contract.

.....Railroad Company.

ARTICLES OF AGREEMENT made this..... day of....., 18.., by and between..... of the first part, and the.....Railroad Company of the second part;

WITNESSETH,—

That in consideration of the prices hereinafter mentioned to be paid by the party of the second part, the party of the first part hereby covenants and agrees to construct and finish in a substantial manner, including the furnishing of materials and other things necessary, to the satisfaction and acceptance of the engineer of the party of the second part, and in strict conformance with the specifications hereunto annexed—which are hereby made a part of this agreement—the following described work upon the railroad of the party of the second part:

.....

.....

And it is hereby mutually agreed between the said parties of the first and second part, that:

[*Time.*]

1. The work shall be begun within .... days after the execution of this agreement, and shall be prosecuted in such a manner as shall, in the judgment of the engineer, best conduce to the progress of contiguous work and the early laying of the track; and the whole of the work herein embraced shall be completed on or before the ..... day of ....., eighteen hundred and .....

[*Work Executed Under Direction of Engineer.*]

2. The work shall be executed under the supervision and according to the direction of the chief engineer of the railroad company and his assistants, whose measurements and estimates, and whose decisions relative to the classification of material, shall be binding on both parties; and the said engineer shall have full power to reject and to condemn any work or material which is in his judgment of inferior quality, or which is not in strict compliance with the specifications attached to and forming a part of

this agreement; and it is agreed that the chief engineer of the railroad company shall be the final umpire in all questions which may arise relative to the work done under this agreement, and that from his decision there shall be no appeal.

[*Classification.*]

3. And whereas the classification of materials to be excavated, provided for in the annexed specifications, is of a character which makes it necessary that special attention be called thereto, it is hereby expresely agreed between the parties to this contract that the determinations by the measurements and calculations of said engineer, of the respective quantities of each kind of such excavation, shall be final and conclusive.

[*Immediate Responsibility of Contractor.*]

4. The work embraced in this agreement shall be executed under the immediate charge of the party of the first part, who shall be responsible for the same, and no portion of such work shall be transferred or sublet without the sanction in writing of the said chief engineer.

[*Incompetent or Riotous Employes.*]

5. The party of the first part hereby agrees to discharge any foreman or other employe who shall, in the judgment of the engineer of the party of the second part, be unfaithful, unskillful or remiss in the performance of his work, or guilty of riotous, disrespectful, or otherwise improper conduct, upon the direction of said engineer for such discharge; and no person so discharged upon this work, or any other work done for the railroad company, shall be employed again by said party of the first part upon the work to be done under this contract.

[*Land Damages at Contractor's Expense.*]

6. The party of the first part shall procure, at ..... own expense, all quarry leaves, roads, temporary rights-of-way, and other real estate, which may be required for the erection of shanties, deposit of materials, or otherwise for the convenience of carrying on the work, when such lands and roads are not already the property of the railroad company, the said company agreeing to furnish only so much ground as shall be necessary for the operation of their railroad, when the same shall have been completed.

[*No Spirituous Liquors.*]

7. The party of the first part shall not permit any spirituous or intoxicating liquors to be brought or be used upon

this work, and shall do everything possible to secure the orderly and peaceable progress of all parts thereof.

[*Damages to Property.*]

8. The party of the first part shall be responsible for any damages that may be done through the performance of this work, to the railroad or other property of the party of the second part, or to that of outside parties, including injuries to crops in consequence of the destruction of fences, opening gates, etc., etc.; and if any such damage shall be done the engineer of the said second party shall have a right to assess the same, and deduct the amount thereof from the payments to be made upon his estimates. Whenever any work herein embraced shall in any manner interfere with the traveled road, public or private, the party of the first part shall keep the same at all times unobstructed and safe for travel, and any damages which may result from the failure so to do shall be estimated and withheld as above,

[*Prices and Payments.*]

9. On condition of the faithful fulfillment by the party of the first part of the agreements and conditions contained in this contract, and the specifications hereto attached, the said railroad company hereby promise and agree to pay said party of the first part, for the work done and materials furnished as aforesaid, at the following prices, to wit:

For clearing, at the rate of....dollars per square.
For grubbing, at the rate of....dollars per square.
For earth excavation, including haul, at the rate of.... per cubic yard.
For loose rock excavation, including haul, at the rate of .... per cubic yard.
For solid rock excavation, including haul, at the rate of .... per cubic yard.
For rip-rap, at the rate of .... per cubic yard.
For rock ballast, at the rate of .... per cubic yard.
For first-class masonry, at the rate of .... per cubic yd.
For second-class masonry, at the rate of .... per cubic yard.
For third-class masonry, dry, at the rate of ..... per cubic yard.
For third-class masonry, in lime, at the rate of ..... per cubic yard.
For third-class masonry in cement, at the rate of .... per cubic yard.
For fourth-class masonry, at the rate of .... per cubic yard.

For concrete, at the rate of .... per cubic yard.
For brickwork, in lime, at the rate of .... per 1,000.
For brickwork, in cement, at the rate of .... per 1,000.
For timber and plank in foundations, at the rate of .... per 1,000 B. M.
For piles in foundation, at the rate of .... per lineal foot.
For piles in bridges and trestles, at the rate of .... per 1,000 B. M.
For wrought iron, at the rate of .... per pound.
For cast iron, at the rate of .... per pound.
For laying track, at the rate of .... dollars per mile.

Which said prices shall be in full consideration for all labor and materials.

And it is further agreed that during the progress of said work, so long as the terms of this contract shall be complied with by the party of the first part, the said railroad company shall make payments to said party of the first part, on or about the middle of each month for the work done during the previous month, upon the approximate estimates of the said chief engineer, less, however, a reservation of .... per cent thereof, which shall remain in the hands of said railroad company as an agreed compensation for damages, to be retained forever by the party of the second part, in case the whole amount of work herein named is not done in accordance with this agreement, it being, however, expressly understood that it will be wholly discretionary with the party of the second part to make any payments on account of materials delivered, and not permanently applied to the work for which they may be intended.

And whenever this contract shall have been completely performed on the part of the party of the first part, and the said chief engineer has certified to the same in writing, the said party of the second part shall within ..... days thereafter pay the said party of the first part any remaining sums due upon said work, according to the terms of this contract.

And for the purpose of avoiding all causes of dispute between the parties hereto, relative to the true intent and meaning of this agreement, it is hereby mutually agreed as follows:

[*Changes of Grade and Allignment.*]

1. No extra payments shall be made on account of changes in either line or grades; but the party of the first part shall be entitled to receive payment for the materials actually handled, but no indirect or consequental damages.

[*Payment of Men.*]

2. The party of the second part may, at its option, require the party of the first part to furnish security with two sureties, acceptable to said second party, that all laborers and other employes upon this work shall be promptly and fully paid by said party of the first part, or the said party of the second part may pay to the employes of the party of the first part, such sums of money as may be due to them for work done under this agreement, and deduct the amount of such payments from the payments to be made upon the monthly or final estimates to said party of the first part.

[*Extra Work.*]

3. No claim for extra work shall be made by the party of the first part, or paid by the party of the second part, unless such work shall have been specially ordered in writing by the chief engineer.

[*Forfeiture of Contract.*]

4. If the party of the first part shall refuse to conform to the directions of the engineer, or in any way violate the conditions of this contract, or shall prosecute the work in such a manner that the said engineer shall have grounds to apprehend that it cannot be completed within the time herein specified, the chief engineer shall serve a written notice upon said party of the first part, setting forth the conditions violated or the grounds of such apprehension; and if such violation of contract or grounds of apprehension are not removed within ..... days after the service of such notice, the party of the second part may give notice to the said party of the first part, that this contract is forfeited, either as to the whole or part of the same; and the said party of the first part hereby agrees to relinquish possession of the work described in said notice, and of the materials procured for the same, immediately upon the receipt of said notice, and forfeit forever the .... per cent of the monthly estimates withheld by the party of the second part as a security for the completion of the work; and the party of the second part shall have the right to enter upon such work and relet the same to other parties, or complete it in whatever manner may appear most expedient to said chief engineer, including the right to put a force upon the same to work under the special direction of said engineer, and to deduct the amount paid to such force from the payments to be made to said party of the first part.

[*Suspension of Work.*]

5. And the party of the second part reserves the right to suspend the work embraced in this contract for reasons not herein specified, and the party of the first part agrees to discontinue all work within ..... days after receiving the notice of such suspension, in which case .... shall be entitled to payment in full for all material actually handled or supplied, but shall make no claim for consequential damages or anticipated profits upon work not actually performed.

IN WITNESS WHEREOF, the party of the first part and the chief engineer of the railroad company, in behalf of the party of the second part, have hereunto subscribed their names, the day and year first above written.

Specifications for Grading.

Under the head of Grading are embraced clearing, grubbing, excavation of all classes, rip-rap and ballasting.

[*Clearing.*]

The lands of the company shall be cleared to the extent required by the engineer, of all trees, bushes, logs and other perishable material, which shall be destroyed or deposited in heaps, as the engineer may direct. Large trees must be cut not more than two feet and a half from the ground, and under embankments less than six feet high they shall be cut close to the ground; all small trees and bushes shall be cut close to the ground.

Clearing will be paid for by the square—one hundred feet square.

[*Grubbing.*]

All stumps, roots, logs and other obstructions shall be removed to a depth of two feet below the subgrade line under low embankments and in excavations, and out of the way of ditches, and in such other places as the engineer may direct.

Grubbing shall be paid for by the square—one hundred feet square.

[*Excavation.*]

The materials excavated shall be divided into three classes: solid rock, loose rock and earth.

[*Solid Rock.*]

Solid rock shall include only rock in its original position, and detached masses exceeding one-half cubic yard each, which cannot be removed without blasting.

[*Loose Rock.*]

Loose rock shall include all kinds of shale, soap stone and other rock which can be removed with pick and bar, and detached stones of less than one-half cubic yard and more than one cubic foot.

[*Earth.*]

Earth shall include all other kinds of material. There shall be no classification of earth other than herein provided for, and it shall include every variety of earth of whatever name or character not unquestionably rock.

All materials excavated from cuts shall be deposited in the embankments, excepting rock suitable for masonry or such other material as may, in the opinion of the engineer, be of value to the railroad company, which shall be deposited in convenient positions under the direction of the engineer. Where the material in the cuts exceeds that required to form the embankments, the surplus shall be used to widen the embankments uniformly, unless express permission to waste has been given in writing by the engineer, in which case spoil banks may be formed under his direction, not less than ten feet distant from the edge of the cutting. Where the material in the cuts is insufficient to form the embankments, the excavation shall be widened uniformly to supply the deficiency, unless the engineer shall have selected a borrow pit for this purpose.

[*Measurement.*]

Materials shall be measured in excavation whenever this be possible, and measurements shall include all cuttings, borrow-pits, roadways, changes of water courses, ditches, foundation and trestle pits, and in fact every kind of excavation usually required. Excavations shall be paid for by the cubic yard, of each class of material, the prices for the same being understood to include all haul. No material will be paid for twice. Wherever the excavations are left in such shape that they cannot well be measured the engineer may measure the materials in embankment; but in such case he shall deduct from the amount actually measured ten per cent for wheel-barrow and shovel work, and five per cent for scraper and team work, to cover loss from shrinkage, when the embankment is made of materials that will settle.

[*Cuts.*]

Cutting in earth shall be ..... wide at the base, with a slope of one to one.

Cuttings in rock shall be ..... wide at the base and shall have a slope of .... inches vertical to one foot horizontal.

All cuts shall be taken out smooth and true.

The dimensions and slopes may be varied by the engineer, when in his opinion the material is such as to render a change expedient.

[*Embankments.*]

Embankments shall be at the subgrade ..... feet wide, and shall have a slope of one and a half horizontal to one vertical in earth, and of one and a quarter horizontal to

one vertical when made of rock. When made of materials which will settle, wheel-barrow and shovel work shall be made one-tenth higher, and scraper and team work one-twentieth higher than the subgrade under the direction of the engineer. No perishable materials will be allowed in embankments. Behind retainer walls and in all places where there is danger of sliding, embankments shall be made in layers not more than two feet thick, care being taken to keep the earth against the retaining wall, or on the outer side of the embankment higher than the other parts When the earth to form the embankments is taken from the sides, the borrow-pit shall be made as far as possible in the form of a continuous ditch, and a berme of not less than four feet, or of such greater width as the engineer may direct, shall be left between the foot of the bank and the excavation, and the slope of the excavation next to the embankment shall not be steeper than the slope of the embankment.

[*Ballast.*]

When good material for ballast is found within one thousand feet, the engineer may require the road bed to be raised one foot above the subgrade with this material, and the contractor shall be paid for the material so handled at the same rates as for excavation of material of the same class.

[*Ditches.*]

In clay-cuts ditches shall be dug along the foot of the slope four feet wide at the top, one foot deep and one foot wide at the bottom, leaving a road bed eight feet wide from the edge of the ditch to the center of the nearest track. To protect the cuts from washing, ditches shall be dug above the cutting, upon ground sloping toward the cuts, and connected with the embankment ditches, when directed by the engineer, and if the material from such ditches is wasted, it shall be deposited between the ditch and the cut. Ditches shall also be dug in other places and for other purposes, when so directed by the engineer.

[*Rip-Rap.*]

Rip-rap will be used to protect the slope of an embankment from the action of water and for other purposes; it shall consist of loose stones of different sizes, which shall be placed carefully upon the slope in a firm and substantial manner, without being laid up in a wall. Rip-rap shall be estimated and paid for by the cubic yard of rock consumed, the measurement being made in the quarry or

estimated for solid cubic yards of rock; the price for rip-rap shall be understood to cover the transportation and placing only, and shall be additional to the usual price of excavating rock of like class.

[*Stone Ballast.*]

Stone ballast shall be made one foot deep above the subgrade, and twelve feet wide on the top. It shall be formed of stones not larger than a cube of six inches, and at least the upper one-third of it shall be formed of stones broken so as to pass through a ring two and one-half inches in diameter. It shall be paid for by the cubic yard, solid measurement in the quarry, which price shall be understood to cover the breaking and placing only of the stone.

The above specifications are hereby accepted.

.....

.....

Specifications for Masonry.]

All stone used for masonry shall be sound, durable, not liable to be affected by the weather, and approved of by the engineer, and shall be laid on their natural beds.

Hydraulic cement shall be of an improved make, newly manufactured, and subject to the test approved by the engineer. Cement mortar shall in general be composed of two parts of sand to one of cement, and shall be used immediately after mixing. Any cement mortar which has begun to stiffen before using shall be rejected.

Lime mortar shall consist of three parts of sand to one of best quicklime. It will only be used in third-class masonry and brick work.

All sand used in mortar must be clean and sharp, free from loam and other impurities, and not too fine.

[*First-class Masonry.*]

First-class masonry will be laid in cement mortar in regular courses, each stone being carefully cleaned and dampened before setting.

The face stones shall be rock-faced, with edges pitched to a straight line, and no projections exceeding two inches. The beds throughout, and the joints for twelve inches back from the face, shall be dressed to one-quarter of an inch, and a draft line two inches wide shall be cut at each angle in the masonry. No course shall be less than twelve inches thick, and the thickness of no course shall be greater than that of the next course below it. No stone shall be cut in the wall. There shall be at least one header to every two stretchers; each stretcher shall be at least eighteen inches wide, and each header at least four feet long, and the least horizontal dimensions of any stone shall not be less than its thickness. The stones of one course must break joints at least one foot with those of the course below, and the headers must be so distributed as to secure the best possible bond. Each stone must be set upon a full bed of fresh mortar, the broadest bed down, and brought to a firm and level bearing without spalls or pinners. Joints shall be packed full of mortar, and the faces afterward cleaned.

The backing shall consist of stones with beds dressed to one-half an inch, and of a thickness not less than one-half that of the corresponding face stones. They shall be laid in full mortar beds, breaking joints, and on the completion of each course the spaces between the larger backing stones shall be filled with small stones, and thoroughly

grouted with a paste made of cement and water without sand, or such spaces shall be filled with concrete, carefully rammed, at the discretion of the engineer.

The coping shall be formed of large, flat stones, at least one foot thick, which shall extend entirely across the wall when the wall is not more than six feet thick. The top and faces of each stone shall be bush-hammered, and the joints and beds cut to one-quarter of an inch throughout.

Arch stones shall have beds cut to one-quarter of an inch, and conforming to the radii of the arch. Each stone must extend through the arch, break joints at least one foot, and measure not less than eight inches on the intrados. The exterior of the arch shall be plastered with a two-inch coat of cement mortar.

[*Second-class Masonry.*]

Second-class masonry shall be laid in cement mortar, the stones being first cleaned and moistened.

The face stones shall have rock faces with edges pitched to a straight line; each stone shall be dressed to a uniform thickness, with beds throughout, and joints for eight inches back from the face dressed to one-half inch. They need not be laid up in regular courses, but shall be well bonded, having at least one header three feet long to every three stretchers, no stone shall be less than eight inches thick, and no stone shall measure in its least horizontal dimension less than twelve inches, nor less than its thickness. The stones shall be laid in full mortar beds, the joints packed full and cleaned.

The backing shall consist of stones not less than six inches thick, at least one-half of which shall measure two cubic feet, laid in full mortar beds and grouted, or the spaces filled with cement.

The coping shall be formed of flat stones at least eight inches thick, with the upper surface bush-hammered, and joints and beds dressed to one-half inch throughout. Each stone must extend entirely across the wall when the wall is not more than four feet thick.

[*Third-class Masonry.*]

Third-class masonry shall be laid dry or in lime or cement mortar, according to the direction of the engineer.

It shall be formed of good quarry stone, laid upon the natural beds, and roughly squared on the joints, beds and faces, the stones breaking joints at least six inches, and with at least one header for every three stretchers. No stones shall be used in the face of the wall less than six inches thick, or less than twelve inches on the least hori-

zontal dimension; headers shall be at least three feet long, or extend entirely through the wall. The end of a wall shall be dressed and stepped to correspond to the slope of the embankment.

In box culverts, the top of course shall extend entirely across the wall, and the covering stones shall have a bearing at least one foot on each wall The covering stones shall not be less than ten inches thick for two feet culverts, not less than twelve inches for three feet culverts, or not less than fifteen inches for four feet culverts. When covering stones cannot be obtained, the engineer may require a rubble arch to be substituted for it, which shall be paid for at the same rate as other third-class masonry.

[*Fourth-class Masonry.*]

Fourth-class masonry will be used in the pavement of culverts, and in slopes and protection walls. It shall be formed of stones of not less than one cubic foot, or less than three inches thick, laid dry and bonded so as to secure the greatest degree of strength, and with beds perpendicular to the face, unless otherwise ordered.

[*Concrete.*]

Beton or concrete shall be formed of clean broken stone or brick, cement and sand. The stones shall be broken so as to pass through a two and a half inch ring, and the proportion of material shall generally be eight parts of stone to three of cement and two of sand. Concrete shall be mixed and handled under the special supervision and direction of the engineer, who will always require a sufficient amount of mortar to fill all voids in the mixture.

[*Brickwork.*]

Bricks shall be sound and hard burned and laid in lime or cement mortar, as the engineer may direct; they shall be well saturated with water before using.

Masonry will be built to conform to plans furnished by the engineer, and, excepting brickwork, will be paid for by the cubic yard. The price paid shall in all cases be understood to cover all false work, scaffolding, centering and other temporary works. Brickwork will be paid for by the thousand in the work, estimating twenty-two and one-half bricks to each cubic foot.

The above specifications are hereby accepted.

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Specifications for Foundations and Timber Work.

Excavations shall be made as directed by the engineer, and materials excavated shall be measured and classified and be paid for at the usual rates for grading. Where pumping or bailing becomes necessary, an allowance shall be made to cover the necessary cost of removing the water.

Timber and plank in foundations shall be of timber approved by the engineer, and shall conform to the plans furnished by him. They shall be paid for by the thousand feet, board measure, and by the pound for the iron consumed in them. Only such timber as forms a permanent part of the work shall be paid for.

All piles shall be straight, sound and free from knots, not less than eight inches in diameter at the smaller end, nor more than eighteen at the larger, and driven as may be directed.

Foundation piles shall be of timber approved by the engineer, and shall be cut off at such an elevation that the timber platform upon them shall always be at least one foot below water.

Piles in pile or trestle bridges shall be of durable oak timber, and stripped of their bark, and cut off square and finished at the elevation given by the engineer.

Piles will be paid for by the linear foot of piles as driven.

Trestle bridges and other frame structures shall be built to conform with the plans and bills of material furnished by the engineer. Only sound live ..... timber shall be used, which shall be well hewn or sawed to the required dimensions, and free from wane. This timber will be paid for by the thousand feet, board measure, and the iron by the pound, estimated weights.

The above specifications are hereby accepted.

.....

.....

CANAL SPECIFICATIONS.

General Contract.

For ..... Canal.

ARTICLES OF AGREEMENT made and concluded the .... day of ....., in the year 18.., between .... of the ..... of ..... county of ..... of the first part, and the ..... of the second part; whereby it is covenanted and agreed as follows:

The said ..... party of the first part hereby covenants and agrees to furnish all materials, which shall be of sound and good quality, and perform all the labor necessary to construct and to finish, in every respect, in the most substantial and workmanlike manner, ... as the same is or may be located for the ..... canal.

The construction of the aforesaid work shall be in all respects according to the specifications hereunto annexed, which are to be considered as part of this contract.

[*Regulation of Employes.*]

And it is further agreed that, if at any time, any overseer or workman employed by the party of the first part, shall be declared to be unfaithful or incompetent by the resident engineer or commissioner having charge of said work on that part of the canal embraced in this contract, the said party of the first part, on notice of such declaration, shall forthwith dismiss such person and shall no longer employ him on any part of the work.

[*Roads—Public and Private.*]

No public or private road that crosses or intersects the line of said canal, or work, shall be obstructed by excavation or otherwise, until directions shall be given by said engineer to commence and complete the canal or work across said road or highway; nor shall any crops of grain, grass or vegetables, nor any dwelling house or other building on said line, be disturbed, unless by direction of said engineer.

And it is further agreed by the said party of the first part, that the work hereby contracted to be done, as far as may be required by the said engineer, shall be carried on so as to facilitate and not to incommode the prosecution of contracts for adjoining and contiguous work.

[*Payments, etc.*]

And it is hereby further mutually agreed, that the said party of the first part will perform the work embraced in this contract, and also that the commissioner in charge will pay out of the moneys in hand, in full compensation for the same, the following sums at the following rates; provided always that the total amount paid by said commissioner to said party of the first part, shall not exceed in the aggregate, the estimated amount of the aforesaid work, including the expenses for engineering:

[*Schedule of Prices.*]

For side chopping, grubbing and clearing, the sum of .... dollars.

For removing ice and snow, and for pumping, bailing and draining, including the expense of constructing and removing coffer dams, excavating ditches, and all other items of cost caused by pumping, bailing and draining, the sum of .... dollars.

For all earth excavations, whether of clay, loam, sand, gravel, pure, mixed or combined, including soft or rotten rock, which in the opinion of the resident engineer, can be plowed, and some measuring less than half a cubic yard, ... cents per cubic yard.

For excavation of all rock, which in the opinion of the resident engineer, cannot be excavated without blasting as cheaply as with blasting, at the rate of .... dollars and .... cents per cubic yard.

For excavation of rock, which in the opinion of the resident engineer, can be excavated without blasting as cheaply as with blasting, at the rate of .... cents per cubic yard.

For embankment, as provided in specifications, at the rate of .... cents per cubic yard.

For lining, as provided in specifications, at the rate of .... cents per cubic yard.

For puddling earth, as provided in specifications, at the rate of .... cents per cubic yard.

For procuring and puddling in gravel in between foundation timbers, and at sheet piling, at the rate of .... cents per cubic yard.

For slope wall and pavement, at the rate of .... dollars and .... cents per cubic yard.

For loose stone at the rate of .... cents per cubic yard.

For loose stone and gravel intermixed with brush at the rate of .... cents per cubic yard.

For vertical or battered rubble walls, laid in hydraulic mortar, at the rate of .... dollars and .... cents per cubic yard.

For vertical or battered rubble walls, laid dry, at the rate of .... dollars and .... cents per cubic yard.

For masonry in abutments, piers, wings, spandrels and parapets, laid in hydraulic mortar, at the rate of .... dollars and .... cents per cubic yard.

For masonry in abutments, piers, wings, spandrels and parapets, laid dry at the rate of .... dollars and .... cents per cubic yard.

For masonry in arches, laid in hydraulic mortar, including centers, and removing the same at the rate of .... dollars and .... cents per cubic yard.

For masonry in arches, laid in hydraulic mortar, including centers and removing the same, at the rate of .... dollars and .... cents per cubic yard.

For coping, at the rate of .... dollars and .... cents per cubic yard.

For concrete masonry, at the rate of .... dollars and .... cents per cubic yard.

For white oak timber, boards, plank and scantling, at the rate of .... dollars and .... cents per thousand feet, B. M.

For white pine timber, boards, plank and scantling, at the rate of .... dollars and.... cts. per thousand feet, B. M.

For masonry in arches, laid dry, including centers and removing the same at the rate of .... dollars and .... cents per cubic yard.

For red beech or white elm timber, boards, planks or scantling at the rate of .... dollars and .... cents per thousand feet, B. M.

For hemlock or spruce timber, boards, plank or scantling, at the rate of .... dollars and .... cents per thousand feet, B. M.

For white cedar or chestnut, at the rate of .... dollars and .... cents per thousand feet, B. M.

For bearing piles, delivered as per bill, at the rate of .... cents per lineal foot.

For driving bearing piles, measured in the work, at the rate of .... cents per lineal foot.

For wrought iron work at the rate of .... cents per pound.

For cast iron work, at the rate of .... cents per pound.

For spikes and nails, at the rate of .... cents per pound.

For zinc, at the rate of .... cents per pound.

For sulphur and sand cement, ... dollars per each structure.

For painting and sanding, at the rate of .... cents per square yard.

For constructing road, at the rate of .... dollars and .... cents per rod.

.....

[*Prices to be in Full Compensation.*]

The prices above specified are to be in full compensation for all materials and labor required to put the same into the work herein contracted for, and complete the whole work in all respects, including the expense of furnishing all the materials and performing all the work according to the plans, specifications and notices exhibited at the letting of said work, which said notice and the papers hereto annexed, as far as applicable, form a part of this contract.

[*Alterations and Directions to be Complied with and Quantities Increased.*]

And the said party of the first part hereby further agrees to perform all the work contracted for, as specified in this contract, but any alteration in the form, dimensions, location or manner of doing work ordered by the commissioner and engineer, shall be made as they direct, and when the several quantities of work, from any cause, occurs that may enhance the cost of the work, shall increase beyond the amount of amounts exhibited at the time of letting this contract, such increase shall be paid for at the rates herein provided for for the same class of work; the party of the first part hereby agrees to perform the remaining work at the prices stipulated in this contract, and to make no claim for damages in consequence of such increase.

[*Fifteen Per Cent to be Retained out of Estimates.*]

And it is hereby further agreed, that fifteen per cent of the amount of work done or materials furnished under this contract, at the contract price thereof, shall be reserved by the commissioner until the whole work which is the subject of contract, shall be fully and entirely completed.

[*Monthly Estimates.*]

And it is further agreed, that within twenty days from the expiration of each month in which work herein contracted for shall have been prosecuted according to the terms and conditions of this contract, the aforesaid commissioner will pay therefor such sums as shall not, together with the former payments, exceed the amount actually due under this contract, according to the estimate of the engineer, except the sum due on the final account; but if, at any time after such payments have been made, the commissioner, or any of the engineers employed on the work, shall discover that any of the work included in the estimates, on which such payments have been made, has

been performed in an unworkmanlike manner, or contrary to the said specifications, the commissioner or resident engineer shall direct the party of the first part to take down and rebuild such work in the manner required by the said specifications, and no further payments on this contract shall be made until the said party of the first part shall comply with such directions.

[*Time of Commencement and Completion.*]

Provided, however, and it is expressly covenanted and agreed on the part of the said party of the first part, that the work hereby specified and embraced in this contract shall be commenced and properly prosecuted at the times and in the manner directed by the resident engineer or commissioner in charge, and that the said work shall be performed and completed on or before the .... day of ....., in the year one thousand eight hundred and.....

[*In Case the Work shall be Suspended.*]

And it is further mutually understood and agreed, that in case the execution of this contract shall be suspended by the party of the second part at any time or for any cause, no claim for prospective profits on work not done shall be made or allowed; but the party of the first part shall have the right to complete the work when the party of the second part shall order it to be resumed.

[*Abandonment of Contract and Forfeiture of Security.*]

And it is further agreed, that if, in the opinion of the resident engineer, the said party of the first party shall refuse or neglect to commence or properly prosecute the work embraced in this contract, or shall violate any of its provisions, or perform the work in an improper manner, the said engineer may certify the same in writing to the board of ....., and in such case the said board or a majority of them, shall have power, by resolution to be entered on their minutes, to certify and declare that this contract has been violated and abandoned by the said party of the first part, and on the making of such certificate the said contract shall be deemed violated and abandoned, and the sum of money, bonds or stocks required by the commissioners as security for the entering into said contract, together with such other additional securities as they may have required, and then hold as security for the completion of the work under this contract, shall be forfeited to the ....., and paid into its treasury.

[*Delays in Progress of the Work.*]

And it is hereby further understood and agreed between the parties to this contract, that in case of delays arising in the progress of the work, either from neglect or inability on the part of the said party of the first part, which may in the opinion of the commissioner in charge, retard the progress of the ..... canal, said commissioner may direct the resident engineer to employ a sufficient force and purchase the necessary materials to complete the work, or such portion of it as may be necessary to secure its completion by the time specified, according to the specifications hereunto annexed, and all expenses incurred in the performance of such work shall be paid for by the said commissioner, on the affidavit of the engineer, and the amount shall be charged to the account of the aforesaid party of the first part.

[*Ardent Spirits.*]

And the said party of the first part further promises and agrees not to give or sell, or allow to be given or sold, by any agent or agents in his or in their employ, any ardent spirits to the workmen or any other persons, on or near the line of said canal, or allow any to be brought on the work by the laborers or any other persons.

[*Work to be Carried on by the Real Parties to this Contract.*]

And the said party of the first part hereby further promises and agrees to perform the several stipulations of this contract by the said party of the first part, and workmen under said party's immediate superintendence, and not be a sub-contract or sub-contractor.

[*Engineer to Determine Quantities.*

And it is hereby further mutually agreed that the resident engineer, for the time being in the employ of the ..... on the work herein contracted for, shall in all cases determine the amount or quantity of the several kinds of work which are to be paid for under this contract, and the amount of compensation to be paid therefor, which compensation shall not exceed the prices agreed upon for the items of work herein specified, or a just and reasonable price for necessary extra work done, directed and ordered pursuant to agreement, and not otherwise provided for, and shall, within ninety days after the work shall in all respects have been completed according to the terms and conditions of this contract, present a final ac-

count and estimate of the same to the commissioner of the ....., who shall review, and when satisfactory appprove.

Witness our hands and seals on the day and year above written.

.....
.....

.....
.....
Commissioners.

.....
Resident Engineer for the State or county by enactment or authority.

State of ....., }
.....County, } *ss.*

On this ..... day of ....., 18.., before me appeared ..... who acknowledged that he executed the foregoing instrument, and I certify that I know the person who made said acknowledgement to be the individual of the first part described in and who executed the said instrument.

.....

Section Specification.

For.....Canal.

[*Specification.*]

1. The canal, when not otherwise directed, to be so constructed that the water shall be ..... feet wide at the bottom, ... feet wide at the top water line, and ..... feet deep; and such a slope preserved on the banks (where not protected by walls), as that one foot vertical rise will give a horizontal base of two feet on each slope.

The surface, or top of towing path shall be at least ..... feet wide, and the berme bank at the foot above the top water line.

[*Grubbing and Clearing.*]

2. From the space required for the canal, and its necessary banks and drains, all trees, saplings, bushes and roots shall be cut and grubbed up, and together with the logs, brush and wood of every description, including all wood fences, shall be burned up or removed from the ground, so as to do no unnecessary damage to the adjoining lands, as may be directed by the engineer employed for the time being, on that part of the line where the work may be located.

All standing trees outside of the canal, which, by falling after the same is completed, might break the bank, or obstruct the navigation, shall be cut down and removed, as may be directed by the said engineer.

[*Excavation.*]

3. Under this head is embraced all the materials to be removed by the prism of the canal, from the sides and bottom of the same, to make room for lining where required, from the foundations of all embankments, receiver, vertical and slope walls, and docking from ditches, back drains and channels for streams.

All materials removed as aforesaid shall be deposited so as to form the necessary banks for the canal, and in such other places as the said engineer shall direct, and when the same are carried over two hundred feet parallel with the line of the canal, for the purpose of making necessary embankments for the canal, or the same distance in a direct line to form bridge embankments, or guard banks (spoil banks not included), the same shall be paid for both as excavation and embankment.

The surplus excavation not required for banks shall be

laid as spoil bank, at such distance from the line of cutting as said engineer shall direct, not more than ten feet, in an even and regular manner, and be carried up with the same slope as the other banks of the canal, and the top finished in a uniform plane, having sufficient declivity, not less than one in twenty, to carry the falling water freely off the back side of the banks.

[*Embankment.*]

4. Under this head is embraced all embanking for the sides and bottom of canal, bridge embankment (excepting a slope of forty-five degrees in rear of bridge abutments), guard banks, or for any purpose required to complete the canal and its necessary appendages.

No materials embraced under the head of excavation, and paid for as such, will, when deposited in any embankment, be paid for as embankment, unless the same has been moved 200 feet in a line parallel with the canal, except as before specified, for bridge embankments, and all embankments made from materials not embraced in the excavation will only be paid for as embankment.

From a space of such width as may be directed by the aforesaid engineer, either under the bank or banks, all perishable matter, and all porous earth, and loose stone shall be wholly removed into the outside of the bank, or, if directed, beyond the limits of the bank; and this work shall in all cases be two chains in advance of the embankment or puddle wall of which it is to form the base or foundation, and directly under the top of the bank a ditch shall be excavated into the solid earth, of such width and depth as the engineer shall direct.

No stone, vegetable matter, or coarse material of any kind shall be deposited within the space extending from the outside top angle to the inside bottom angle of the embankment, and particular care must be taken to select the most water tight material for this part of the embankment, and when required a puddle wall, of such materials as are hereinafter described, shall be carried up regularly with the embankment from the bottom of the aforesaid ditch to the level of top water line.

And when a puddle wall is carried up, care shall be taken to put suitable fine earth next to said puddle wall, to give it a firm and uniform support.

In carrying up the work, the materials shall be laid on in an even and regular manner, in courses not more than eighteen inches in thickness, and be kept free from ridges and hollows. When required by said engineer, the materials shall be carried on in carts and wagons.

The materials shall be obtained from the nearest sur-

plus excavation, or such other place or places as the said engineer may direct.

When the earth for embankment is taken from the outside of the canal, the cut from which the earth is taken shall be left smooth and even, so as to do no unnecessary injury to the land from which it may be removed.

When the foundations of the banks of the canal are below the level of canal bottom, the bases of the embankments shall, when required by said engineer, be increased in width above the dimensions specified in the first specification, and such extra width shall be carried to such height as shall be directed.

When the canal is constructed across marshes or soft places, into which the embankments are liable to settle, such increase to the slopes of the banks shall be made as the engineer shall direct, and the quantities of embankment, in all such cases shall be determined by measuring the excavation whence the materials are obtained, and no deduction shall be made for shrinkage.

[*Lining.*]

5. Under this head are to be included all the materials placed upon the bottom and sides of the canal to prevent leaks, all the gravel required to be placed behind the docking, vertical and slope walls; also on the top of the embankments and the outside slopes.

In all cases where the bottom of canal or slope of banks is prepared to receive a course of facing, either for lining the canal or to prevent washing in rear of docking, slope or vertical walls, or graveling tow-path, the materials put on to form such facing shall be estimated as lining, and all materials for said lining obtained from prism of canal, back drains or other necessary excavation within 400 feet of the point used, shall be deducted from the amount of said excavation, and all materials for facing banks as above described, obtained without the bounds of any nec essary excavation, shall be estimated as lining only.

Lining shall not be paid for in any case where preparations are not made for receiving the facing above described, nor when the materials composing the prism of canal and embankments are of such a character as not to require the same.

In all cases where the material in excavation, or from which the embankment is made, are not sufficiently impervious to form the face of banks or bottom of canal or suitable for puddle walls or for backing the inside slope wall, and completing the inside angle or top of towing path, or for covering a rock surface to prepare it for a course of impervious lining or puddle, resort shall be had to other

sources for such materials as may be required for these purposes.

[*Puddling.*]

6. The materials for puddling shall be composed of clay-loam intermixed with a suitable proportion of fine gravel, the whole to be well incorporated and laid on in courses of six inches in thickness, to be properly wet, and worked into a compact, solid and impervious state.

When a course of puddle is not carried forward as soon as the preceding course is set, the work shall be covered so as to protect it from injury by cracking or checking.

Course of puddle shall be laid at waste weirs, culverts and aqueducts, and over the bottom of the canal, and a puddle wall carried up in the bank or banks at such places as the aforesaid engineer may direct, who shall determine the form and dimensions of the same.

The compensation for the labor of puddling will be for the work after the materials are delivered, to be measured after the puddling is completed. The materials puddled will be paid for either as lining or embankment, as the case may be, but no other allowance will be made for puddling.

[*Slope and Pavement Wall.*]

7. Where a slope wall is required on the outside of canal, a space of suitable dimensions for thickness of the wall, and the required lining or backing shall be formed in the excavation, or left in the embankment, so as to allow the foundation of the wall to be commenced at bottom of the canal (or as may be otherwise directed by said engineer), and the wall carried one or two feet above top water line, connected with a pavement, which is to be carried over the front angle of towing-path, and three feet back of the same; to be six inches thick, and to consist of small field stone, of uniform size, compactly laid on their ends, well bedded in gravel, and firmly moulded down.

When required, the foundation of the wall to be of timber or plank, the wall to be composed of field or quarry stone, of good shape, and be laid in a compact, smooth and substantial manner, at right angles with the slope, and the joints all properly broken.

The wall shall have an average thickness (measured as above) of fifteen inches; and more whenever the engineer shall deem it necessary to protect the work; and no stone shall be laid in such wall less than twelve inches in length, at right angles to the face.

The rear of the wall is to rest on a base of clean, hard gravel, at least nine inches thick, at right angles with face,

and all the spaces shall be well and thoroughly filled with the same material. The compensation for the wall is to include the expense of filling the space with gravel.

Whenever a slope wall is to be built upon the outside of the banks, to protect them from the abrasure of streams, and where the water is so deep that it cannot be commenced on the bottom of such streams, nor upon the solid bank thereof, a rip-rap of stone embankment, or apron of loose stone, shall be deposited within the stream at such place or places as the engineer may direct, and be raised to within one foot of the usual level of low water mark of such streams, and be of such dimensions as shall be required by the engineer, to be paid for as loose stone filling. When required, cribs of timber filled with stone shall be substituted for the rip-rap apron.

The rear slope or protection wall shall have an average thickness of not less than two feet, measured at right angles with the face of the bank, and the slope of the wall shall conform to the slope of the bank, which may vary as the engineer shall direct. The stone shall be of good quality, and of such size and form as the engineer may direct, and shall be laid in a smooth, compact and substantial manner. In all cases the stone shall be laid at right angles with the face of the bank, and all the spaces be thoroughly filled with clean, hard gravel. The compensation for the wall is to include the expenses of filling the space with gravel.

[*Docking.*]

8. Where required for protecting the slopes of the canal, a docking of timber, or of timber and plank, shall be constructed and secured with ties and anchors, and be well tree-nailed, as shall be directed by the said engineer; and the front angles finished with a pavement, in a manner similar to that of banks with slope wall. No allowance will be made for excavating the trenches for the ties and anchors, or filling up the same. This expense is to be included in the price of the materials for docking.

[*Vertical or Battered Walls.*]

9. Vertical or battered walls, laid dry or in hydraulic cement, and resting upon foundations of timber and plank, or otherwise, shall, when required, be constructed on the inside face of the banks of the canal, and at such other places, and of such form and dimensions, as shall be directed by the said engineer.

The wall to be composed of sound, well shaped and durable quarry stone, not less than six inches in thickness and three feet area of bed. The smoothest and broadest

bed shall in all cases be laid down; and when the setting bed is rough or uneven, the projecting points shall be hammered off. All high projecting points on the top bed shall also be hammered off, so as to give the succeeding stone a firm bearing.

In all cases the bed shall be properly prepared by leveling up before the next stone is laid. But no levelers shall be placed under a stone by raising it from its bed.

One-fourth of the wall shall be composed of headers that shall extend through the wall where it is not more than two and one-half feet thick, and from two and one-half to four feet back for thicker walls.

The whole of the wall shall, when required, be laid in hydraulic mortar, composed of the best quality of cement, and clean, sharp sand, in such proportions as the said engineer may direct.

If the said engineer shall direct, the foot and rear stones shall be laid in mortar, and the interior of the wall grouted with similar materials, as above specified for mortar. Such portions of the wall as may be required by said engineer shall be leveled up to the regular course, of such thickness as may be directed.

The wall, when laid dry, to be thoroughly graveled, in a manner similar to that above specified for slope wall. When required, the wall shall be coped with stone, at least six inches thick, two feet six inches width of bed, and three feet long, or with timber, as may be directed.

[*Roads.*]

10. Roads shall generally be constructed twenty-five feet wide between the ditches, and crown two feet. From this space, all trees, stumps and roots shall be grubbed up, and all trees and bushes within the boundaries of the road cut down, burned up or removed.

All knolls and hills shall be cut down, as may be directed, and reduced to uniform planes, and proper sluices put in the depressions. Large side ditches shall be constructed, which shall have a proper declivity toward the sluices.

The excavation from the ditches will generally be used to form the roadway.

All stones projecting above the surface shall be thrown out. The expense of all the work shall be included in the price for road per rod, except the sluices, which shall be paid for at the contract price for similar work on the section.

[*Further Details.*]

11. For a more full and perfect explanation of the form and dimensions of all the work, and of the manner of executing it in all its details, plans and bills of timber will be furnished by the said engineer, who will also give such directions, during the progress of the work, as may appear to him necessary to have the same done in every respect complete and perfect, on the plan contemplated in the foregoing specifications; and the said directions shall, in every respect, be complied with.

Culvert Specifications.

For ..... Canal.

GENERAL DESCRIPTION.

The culverts to be composed of abutments, piers, arches, wing walls and parapets of stone masonry, and in some cases the culverts to be in part composed of timber and plank. When rock does not occur, a foundation of timber and plank, or of plank alone, is to be put down in all cases; and when required by the resident engineer in charge of the work, bearing piles shall be driven to support and protect the foundation.

[*Specification.*]

1. The foundation pit shall be excavated in such form and dimensions, and the earth from the same shall be deposited as may be directed by said engineer, and the bottom made smooth and even, to give a firm and uniform support to the foundation. If the material shall be removed 200 feet from the place excavated, and be deposited in a necessary bank, it shall be estimated both as excavation and embankment.

[*Foundation.*]

2. If the ground on which it is to be placed shall require bearing piles, the same shall be driven and secured to the foundation timbers as shall be directed. When rock does not occur the foundation shall be composed of hemlock timber from six to twelve inches in thickness, as may be required, and covered with hemlock plank properly tree-nailed to the timber. Except when otherwise directed, the foundation shall extend and cover the space between the abutments and the piers. The spaces between the timbers shall be filled with fine, clean gravel, well puddled in, or otherwise concrete, as shall be directed by the engineer.

[*Sheet Piling.*]

A course of sheet piling from three to six feet long, shall be put down along the upper and lower side of the foundation, and at such other parts as the said engineer may direct. The manner of putting down them shall be by excavating a ditch to the depth of the sheet piling, and placing the pile plank edge to edge and spiking the heads to the foundation timber, so as to make the work close and

substantial; except where otherwise directed, a lining course of inch boards shall be put over the plank, so as to break joints with them, and be secured by nails. The space each side of the piling shall be filled with fine, hard gravel well puddled in, or with concrete, as the engineer may direct.

[*Masonry.*]

3. The face of the abutments and piers to be carried up plumb or on a batter. The ends of the abutments and piers, and the exterior face of the parapets and wings, to have a batter of from one-twelfth to one-sixth their rise; and the interior face or rear of the wings and parapets to be carried plumb to within four feet of top, from which point to the top of the wall the rear shall batter one-fourth the height. The rear of the abutments to be carried plumb, with such offsets as may be directed by the said engineer. The parapets and wings shall not be less than two and a half feet thick at the top, and covered with a coping stone that shall project from two to three inches over the face of the walls; the coping shall not be less than nine inches thick for culverts not exceeding six feet chord, and a corresponding increase for larger culverts, and shall not be less than two feet nine inches wide, and not less length than width. The wings and abutments shall be supported with buttresses, and in all cases under the inside angle of the banks, buttresses projecting from two to four feet from the abutments, and two and a half to four feet thick, shall be carried up at least two feet above the crown of the arch; suitable pilasters shall be carried up on the face of the wings. The dimensions of the masonry will vary with the dimensions of the culverts, and shall in all respects conform to the directions of the said engineer. For culverts of four feet chord and under, the wings shall be straight, and those over four feet shall, if directed, be curved.

The masonry to be formed of sound, well shaped and durable stone. The beds of the arch stone to be dressed to one-fourth of an inch joint, so as to bring the line of the bed joints in the line of the radius of the curve of the arch, and no stone to be laid in the arch that does not fill the entire depth. The end joints of the arch stone shall be dressed to a similar joint for two-thirds the depth of the arch; the remainder may be spalled off at an angle not exceeding twenty-two and a half degrees, provided it does not reduce the back of the stone to less than one foot, and the extrados to be rough dressed, and filled with hydraulic cement, which shall form a complete and smooth plastering over the whole arch. The ring stone to be well bonded with the contiguous arch stone, and with the face stone of the

wings, parapets and spandrel walls. The thickness of the arch stone for culverts not exceeding eight feet chord, shall not be less than six inches for culverts of eight to fifteen feet chord, eight inches; and over fifteen feet chord, twelve inches. The depth of the arch stone for culverts not exceeding seven feet chord shall be from twelve to fourteen inches; for culverts of seven to ten feet chord, fourteen to sixteen inches; for culverts of ten to sixteen feet chord, sixteen to twenty-one inches; for culverts of sixteen to twenty feet chord, twenty-one to twenty-four inches; for culverts of twenty to twenty-five feet chord, twenty-four to thirty inches at the base, and twenty-four inches at the top. The face stone of the masonry in the abutments, piers, wings, spandrels and parapets, shall be dressed on the beds to one-fourth of an inch joint, twelve inches back, for culverts not exceeding six feet chord; fifteen inches for culverts of six to ten feet chord; and eighteen inches for culverts of more than ten feet chord. The end joints for culverts not exceeding six feet chord shall be dressed back six inches; for culverts six to ten feet chord, nine inches; for culverts more than ten feet chord, twelve inches back to one-fourth of an inch joint. The remainder may be spalled off as in the arch stone, except the intrados and coping. The face of the masonry shall be rock dressed, and a draft of arris one inch in width shall be cut around the edge of each face stone, and the rock projection shall not exceed two inches. The intrados shall have the same character of dressing as the beds.

[*Coping.*]

The upper and lower beds, and the end joints for the full breadth of the stone, shall be dressed to one-fourth of an inch joint, and the face made to correspond with the dressing on the parapets.

The face stones shall be laid in regular courses of not less than six inches for culverts not exceeding ten feet chord, and a suitable increase for larger culverts; not less than nine inches as a minimum course. In larger courses, the said engineer may direct the adoption of one or two stone alternately in the same course.

The stretchers shall have a breadth of bed of at least one and a half times the depth or thickness of the course, and in no case less than fifteen inches for culverts of six feet chord and under, and eighteen inches for those over six feet chord. The breadth from front to rear, of headers, shall be two and a half times the depth of the course, and in no case less than twenty-four inches for culverts of six feet chord and under, and thirty-six inches for those over six feet chord; subject to such modification as the depth of

course and thickness of the wall may in the opinion of the said engineer, render necessary and proper. The rear of the walls shall be laid true and even. One-fourth of the wall in each course shall be occupied with headers, arranged in such a manner as to give the greatest stability to the work.

The backing and interior wall shall be composed of large, well shaped stone, and in no case less than six inches thick, and three feet area of bed, and laid to form a good bond. The lower bed shall be dressed level and even, and leveled up on the top to fair beds before the succeeding stone is laid, but no levers shall be placed under the stone after it is laid.

The stone in the whole masonry shall be well bedded in hydraulic cement, made of the best quality hydraulic lime, and clean, sharp sand, in such proportions as the said engineer may direct and the vertical joints grouted with similar materials, and subject to the same directions. Each course shall be fully grouted before another is commenced; and no spalls or small stone shall be filled in any place until after the grouting is in. The masonry to be carried up in regular courses, and the work, in its progress, to be kept as uniform in height as practicable. The stone shall be kept wet, and free from all dirt. No dressing shall be done on a stone after it is laid that will disturb the setting of the cement.

If, in the opinion of the said engineer, it shall be necessary to carry up masonry during a season when mortar can not be used, unless the work is covered by sheds, and protected from the operation of frost by the use of stoves, such covering and stoves shall, if in his opinion necessary, be erected and provided; and during the progress of laying the work, and until the mortar shall have become firmly set, such a temperature shall be preserved in the buildings as will effectually protect the masonry from injury by the frost. If mortar is not required to be used at such seasons, then the masonry shall, if directed, be laid dry, and grouted and pointed in the spring, and in order to allow the grout to distribute itself thoroughly through the work, suitable openings shall be left in the abutments and spandrel walls. The centerings of the arches shall also be made sufficiently tight to prevent the escape of the grout from that portion of the work. During the process of laying, the stone shall be kept entirely clear from ice and frozen earth.

[*Composite Culverts.*]

4. The foundation and masonry to be as provided in the foregoing specifications.

The sides of the culverts to consist of white oak, white pine, or hemlock timber, from eight to twelve inches wide, and twelve inches thick for culverts of two feet high; and ten to fourteen inches wide, and eighteen inches thick, for culverts of three feet high. In culverts of greater size, the width and thickness of the timber shall be increased proportionally. The timber to be set on edge, and firmly connected with white oak dovetailed keys, two inches thick and four inches wide, placed once in five feet; a white oak treenail, two inches in diameter, shall pass through the center of the timbers, intermediate the keys.

The side timbers to be connected with foundation by treenails, and wrought iron bolts, placed as often as may be directed; the bolts to be secured at the top of covering plank with screw and nut. The side timbers shall be at least twenty-three feet long each, and be well lapped and so placed as to break joints with each other; and shall, when required, be grooved, and tongued with a white oak tongue, half an inch thick and one inch wide. In cases of two or more spaces, a partition shall be made in the same manner as described for the sides.

The floor shall be lined with one and a half inch white pine plank, well jointed and treenailed to the foundation timbers.

The top of the culvert shall be covered with white pine or hemlock timber, from four to ten inches thick; said timber shall be well grooved and tongued as above, and shall be boxed down half an inch, and shall be firmly treenailed to the timbers on which they rest.

After the work shall have been fully grouted, the extrados of the arch or top of coping and top of abutments (and spandrels if any) shall be well covered with a plastering of hydraulic cement; and if directed, a course of concrete masonry shall be placed over the surface so plastered, or over any portion of the same.

5. For a more full and perfect explanation of the form and dimensions of materials and parts, and of the manner of constructing the culverts and small aqueducts in all their details, plans, with bills of timber and iron, will be furnished by said engineer; who will also give such directions, from time to time, during the progress of the work, as may appear to him necessary and proper, in order to make the work in every respect complete and perfect, on the plan contemplated in the above specifications. And the said plans, bills of timber and iron, and directions, shall in every respect be complied with.

Waste-Weir Specification.

For.....Canal.

GENERAL DESCRIPTION.

The weir to be formed by abutments of stone masonry, crossing the bank at right angles, and when on the towing path side of the canal, a culvert or archway shall be made to support to towing path, from which the walls shall be joined by curved sections to the abutments that pass the remainder of the bank; the whole supported on a foundation of timber and plank. The walls to be sloped to conform to the slopes of the bank, except where it may be necessary to carry up a portion of them to add to the facility of managing the gates.

The top of all the walls, except the parts occupied by the arches, to be coped with cut stone. Between the abutments, a gateway frame of white oak timbers is to be erected, with the gate spaces twenty-four inches in the clear in breadth, and thirty inches in height; and the remainder to the plate timber, planked up with white pine plank, matched with tongue and groove. The gates shall be made of cast iron, with wrought iron rods, and operated by a lever.

When directed, the foundation and the waste-weir shall be extended on each side of the gates, and connected with the abutment walls to be constructed at each end of the extended section of the weir. This section of the weir to consist of three walls; the first or upper wall to extend each way from the archway to the end abutment walls to support the embankment and said abutment walls. The second wall to extend in like manner from the gateway, and serve as a bulk-head and waste for the surplus water. At eight feet below the last mentioned wall, a wall shall be built of such dimensions and form as may be necessary to conduct the water into the channel below.

[*Specification.*]

1. Excavation of pit to be of such form and dimensions as may be directed by the resident engineer in charge of the work.

The pit when excavated to the proper levels, shall be made smooth and even, so as to give a uniform bearing and support to the foundation timbers.

[*Foundation.*]

2. Under and outside the gates, the foundation shall be sunk to such a level below the inside section as said engineer shall direct, and be composed of timber twelve inches deep, and not less than ten inches wide, and of sufficient length to extend from the rear of one wall to the rear of opposite wall; and covered with a course of three-inch hemlock plank, and lined with a course of two inch pine plank between the walls. From this section of the foundation, when directed, a projection shall be extended on the same level, to support the extension of the weir and end abutment walls. The inner section of foundation shall be composed of timber ten inches thick, and not less than ten inches wide, of sufficient length to extend from the rear of one wall to the rear of opposite wall, and covered with a course of two-inch plank, over which a lining of inch boards shall be laid between the abutments. The level of foundation floor for inner section shall be one and a half feet below bottom level of canal. The spaces between foundation timbers, and each side of sheet piling, shall be filled with fine, clean gravel, well puddled in, or with concrete masonry. The plank shall be well treenailed to the foundation timbers.

[*Masonry.*]

3. The masonry to be formed of sound, well-shaped and durable stone. The beds, end joints and face to be well hammer-dressed, so as to make firm and substantial work, not having a face joint over a quarter of an inch in thickness, and laid in regular courses of not less than nine inches in thickness; but in courses of twelve inches and over, the course may be alternately formed of one and two stone in thickness or depth of course.

The stretchers shall have a breadth of bed of at least one and a half times their rise, or the depth of course; and the breadth from front to rear of headers shall be two and a half times the depth of the course. One third of the wall in front and rear in each course shall be occupied with headers, arranged in front and rear in such a manner as to give the greatest stability to the work. The sheeting of the arch shall be laid in courses not less than six inches in thickness on the face, and twelve inches deep. A parapet wall shall be carried up on the rear end of the arch four feet above the crown of the same, and coped with cut stone 8 inches thick, and not less than three feet long and 28 inches wide, projecting two inches on each side over the parapet. The inside parapet shall be raised one foot above the crown of the arch, and coped with cut stone laid in such form as to admit of a connection with a pavement

wall corresponding with the adjoining pavement upon the front angle of the towing path. The thickness of courses in parapet and spandrel walls may be six inches.

The face and rear stone shall be well bedded in hydraulic cement, made of best quality hydraulic lime, and clean, sharp sand, in such proportions as said engineer may direct, and the interior grouted with similar materials and subject to the same directions; each course shall be fully grouted before another is commenced, and no spalls or small stones shall be filled in any space until after the grout is in. The masonry to be carried up, or progress in regular courses, and of such width as to conform to the width of the wall.

The coping not before specified, shall be 10 inches thick, two feet wide and three feet long, projecting two inches over the face of the work. A tie rod and anchor shall be put in to support the lower coping on the inner slope. The abutement walls shall be formed so as to give a proper rebate to support the gate frame; and a foot plank two and a half inches thick and two feet in width shall be put in proper recesses in the wall, to facilitate the work of opening the gates.

The wing buttresses shall extend from the lower foundation, or be a continuation of the breast wall beyond the abutments, and may be directed by said engineer and carried up to one foot above top water line.

[*Gateway.*]

4. A breast timber of white oak, 12 by 14 inches, shall be placed down, for the foundation of sill of gate frame, into which white oak posts shall be framed, so as to leave spaces of 30 inches clear between them; the posts shall be capped with a white oak plate timber at the proper level for the waste water to flow over.

[*Explanatory Note.*]

In cases where a weir is located on the berme side of canal the culvert arch, and all that peculiarly appertains tothe accommodations of the towing-path, shall be omitted.

A more full and complete explanation of the forms and dimensions of materials and parts, and of the manner of constructing the weirs in all their details, plans, with bills of timber and iron, will be furnished by said Engineer; who will also give such directions from time to time, during the progress of the work, as may appear to him necessary and proper, in order to make the work in every respect complete and perfect, on the plan contemplated in the above specifications. And the said plans, bills of timber and iron, and directions, shall in every respect be complied with.

Lock Specification.

For.....Canal

GENERAL DESCRIPTION.

For a Lock of Eight Feet Lift.

Locks to be composed of hydraulic stone masonry, placed on a foundation of timber and plank.

The chamber to be 18 feet wide at the surface of the water in the lower level, and 110 feet long between the upper and lower gate quoins.

The side walls to extend 21 feet above the upper gate quoins, and thirteen and three-fourths feet below the lower gate quoins. The side walls at the head to be terminated with rectangular wing buttresses, and at the foot with straight wings 25 feet in length, slightly curved at their connection with the main walls, and spreading each side at the end of 5 feet wider than bottom line of lock walls. In cases where two or more rocks shall be combined, culverts formed of large stones cut to one-fourth of an inch joint, to pass the water from rock to rock, shall be constructed in the walls, with proper apertures for valves, rods and ventilators; and such modifications shall be made in form and dimensions of the walls, as the resident engineer in charge of the work shall direct.

1. Lock Pit.

To be excavated of such length, width, depth and slope, as may be required by the said engineer, and the bottom made smooth and level, so as to give a firm and uniform bearing to the foundation timbers.

The earth or rock excavated from the pit shall be deposited, so as to form as large a proportion of the lock embankment as the said engineer may direct.

2. Foundation.

If the bottom is of earth, which in the opinion of the aforesaid engineer, is not sufficient to support the foundation, then bearing piles of hard wood, not less than ten inches in diameter at the small end, and of such length as may be required, shall be driven as described below, to support the foundation.

The piles shall be driven with a hammer weighing not less than 1600 pounds, and raised as high as may be with leaders 35 feet long.

There shall be four rows of piles under each main wall, and one row in the center of the lock. The piles shall be driven in rows, at three feet from center to center, except when otherwise directed by the aforesaid engineer.

The piles to support the wing and the breast walls, and wing buttresses, and also under the miter sills, shall be driven in rows to conform to the form and shape of the same. The heads of the piles to be cut off smooth and level, to receive the foundation timbers. The piles to be paid for as delivered, for the amount contained in the bill furnished by said engineer; and to be paid for as driven, for the amount which the piles measure after being prepared to receive the foundation timbers. The foundation timbers to be twelve inches square, and of such length as will extend from and cover the outside piles, and to be treenailed with a two inch white oak or white elm treenail, or with iron bolts twenty-four inches long in each pile.

If the bottom is of earth, sufficiently compact and firm to support the foundation without bearing piles, then the foundation shall be composed of timber 12 inches thick, and not less than 10 inches wide, counter-hewed on the upper side, and the timbers to average 12 inches wide; to be placed at uniform distances, according to their width, so as to occupy or cover at least three-fourths of the area of the foundation, and under the lower miter sill, to be placed side by side; in all cases to be of sufficient length to extend across the lock to the back lines of the center buttresses, and at the head and foot of the lock to the rear or back line of the wing walls.

The timbers under the lower miter sill to be white oak, white elm or red beach; and the other foundation and apron timbers to be of hemlock.

The foundation to be extended 3 feet above the face of the main wall at the head of the lock; and at the foot, 6 inches below end of wing walls.

The length of the foundation, exclusive of the apron at the foot, to be one hundred and seventy-three feet three inches.

That portion of the spaces between the timbers in all cases to be filled with concrete masonry, as the engineer may direct.

In the cases where rock composes the bottom of the lock, the foundation timbers, if required, shall be 10 inches thick under the lower miter sill, and 8 inches thick at other places, and placed at such distances apart as may be directed, and laid in hydraulic mortar. The spaces between the timbers, so far as may be directed, to be filled with rubble, hydraulic or concrete masonry. Where the rock is of such character that timber is not required for the foun-

dation, the same shall be excavated smooth and level, and the first course of the stone well fitted to the rock without extra charges for the same.

[*Apron.*]

There is to be an apron extending below the lower end of wing walls not less than 30 feet, composed of timber laid parallel with the other foundation timbers, extending under the vertical walls covered with two inch hemlock plank, or it may be composed of quarried stone pavement, set up edgewise 18 inches deep, either to be built as the engineer shall direct.

[*Sheet Piling.*]

In all cases where rock does not occur there shall be a course at the head of the foundation, under each set of gates, and at the lower end of the wings and at the lower end of the apron to be from four to six feet deep, as may be required. In each case to extend across the whole foundation.

The sheet piling to be of 2-inch hemlock plank lined with 1-inch pine boards. Ditches to be excavated to receive the sheet piling, which are to be placed edge to edge, and the top well secured by spikes to the foundation timber.

The spaces excavated as above to be filled up with fine, hard gravel, well puddled in, or with concrete, so as to render the work impervious to water.

[*Flooring.*]

A course of two and one half inch of pine or hemlock plank to be laid over the whole of the foundation timbers, except a space 3 feet wide under the face line of each wall, which shall be covered with two and one half inch white oak plank; the whole to be well jointed, and every plank well treenailed, with two white oak treenails at each end, and at every three feet in length to enter the timber at least five inches, or with wrought iron spikes, as the engineer may direct; the treenails to fill an inch and a quarter bore.

The floor plank in the chamber of the lock, and other parts where a lining course is to be laid and for three feet under the walls, shall be sized true and even to form a close and uniform support to the lining plank; on this floor the superstructure is to be erected.

3. Platform for Upper Gate and Valves.

There is to be a platform for upper gate and valves to consist of a frame work of timber extending across the lock and raised to within 3 feet of canal bottom at

upper level. In this platform the valves are to be inserted. They will lie horizontally inclosed, and will be operated by levers, rods and shackle bars from the side of the lock. On this platform a tumble or drop gate is to be erected, all to be according to the plan and directions of the engineer.

4. Miter Sills.

To be of best white oak timber 9 inches thick, and of such length and width as may be directed by the aforesaid engineer. To be well jointed and bolted to the foundation or platform timbers as the case may be, with bolts of iron 20 inches long and one inch square, well ragged and headed. There will be 9 bolts in each miter sill.

5. Masonry.

The main walls for twenty-one and a half feet in length from the wing buttresses at the head, and 32 feet of the lower end to be 9 feet eight and seven-eighths inches thick, including the recesses, and for the intermediate space to be 7 feet eight and seven-eights inches thick, with 3 buttresses projecting back two and one half feet, and 9 feet long, placed at equal distances apart, leaving spaces of 15 feet between them, and to have an offset of 6 inches in thickness at 5 feet below the top. At two and one half feet below the top of the walls the buttresses are to terminate; and at 4 feet below the top such offsets made in other parts of the wall as will leave them, after allowing for the inside batter and one foot for the outside batter in this 4 feet, the coping width at the top. The height of the wall to be seventeen and three-fourths feet.

The walls of the chamber each to have a batter on the face of half an inch per foot rise to the top of the wall. The same batter to be made in the walls, from the lower quoin to the ends of the wings. The nose of the quoins to be placed in line of chamber, and to curve on an increased radius, so as to conform to the batter.

[*Quoins.*]

The quoin stones in which the head post is to turn, shall not be less than four and one half feet in length in the line of the chamber, and be cut and formed to a curve of 7 inches radius; the nose to be rounded, and the heel beveled to the rear of the recess. The quoin stones to be alternately header and stretcher.

[*Recesses.*]

The recesses for the lower gates to be 20 inches deep at the top of the wall, and 12 feet long, with sub-recesses 9 inches deep, 6 feet high and 10 feet long for the valve gates.

The ends of the recesses opposite the quoin to be finished with a miter bevel.

The recesses of the upper gate to be of such forms and dimensions as may be required for the insertion of a tumble gate.

Wing buttresses at the head of the lock to be 3 feet thick and extend on the bottom to the upper edge of foundation, and carried plumb to the whole height of the main wall.

Breast wall to commence five and one-fourth feet below the upper end of the foundation, and extend across from side wall to side wall, to be 5 feet wide and 8 feet high, finished with a coping of cut stone.

[*Wing Walls.*]

The wing walls at the point where they join the main walls are to be seven and three-fourths feet thick, and at the end to be six and one half feet thick on the foundation. At four feet below the top of the walls an offset is to be made which, after allowing one foot for the batter on the rear of the wall, shall leave the coping width of 3 feet at the top. If the lift of the lock is more or less than 8 feet, then the height and thickness of the walls to be varied, as may be determined by the said engineer.

[*Character of the Work.*]

The face stone of the masonry shall be of gray or blue lime stone, of sound and good quality, to be cut true and even; the upper and lower beds to be parallel; the cutting to be done and the work laid with a mortar joint, that shall not exceed in any place one-fourth of an inch in thickness, excepting that part of the vertical joint beginning 12 inches from the face of the wall, and extending to the rear of the face stone, which shall not exceed one inch in thickness.

The lowest course of face stone shall not be less than 18 inches, and the second course not less than 30 inches wide on top. The second course shall in all places break joints at least 12 inches on the backing, immediately in the rear of the face stone below it, and shall have a header two and a half feet long on the face extending back into the wall at least four and a half feet, one in every 10 feet in length of wall; every succeeding course of masonry shall have like headers therein, so laid that in alternate courses they will be intermediate to each other.

The face of the wall shall be made of such alternate course to the coping.

No course of face stone shall be less than 12, nor have more than 30 inches in thickness. If any course exceed 18

inches in thickness, it shall have as much bed as height. Each stone in every course shall break joint at least one foot with the stone on which it rests.

The backing shall be of any stone, of sound and good quality, which the said engineer shall approve; to be laid in courses with similar headers in each course, placed intermediate to the headers from the front. The backing stone shall in no case rise higher than the face stone in any course of the masonry, and no dressing of stone will be permitted after they are laid into the work. The bed joints in the backing shall not exceed one inch in thickness in any place, and the vertical joints therein shall not exceed an average of two inches; but the backing stone must all be in contact in some places at the beds and vertical joints, and especially with the rear of the face stone. The backing stone shall break joints at least six inches, and no stone shall be less than six inches in thickness, nor have less than four square feet of surface.

[*Coping.*]

The walls are all to be coped with cut stone. At the head of the lock, at the recess and quoin corners, and for a suitable distance above and below the recesses, the coping stone shall be 5 feet wide on the top, at the recesses it shall be 3 feet 4 inches wide; on the chamber walls 4 feet wide; and on the wing walls 3 feet wide on the top. All the coping to be not less than 15 inches thick and uniform in thickness; and to increase in width downwards from the top, to conform to the batter on the wall. The length of each coping stone to be equal to the breadth of the course.

And the head and foot of lock the coping to be secured by dowel bolts of iron, and two clamps to each joint; and from the head to the second joint below the lower recess each coping joint to be secured with two clamps of iron; each clamp to be 9 inches long, 2 inches wide, and five-eighths of an inch thick, and let into the wall so as to make the top level with the coping.

The bolts and clamps to be well secured by a cement made of sulphur and sand, in such proportions as shall be directed by said engineer.

The inside upper corner of the coping of the lock to be finished with a round corner of 3 inches radius; in other respects the stone to be cut to a straight line on all sides.

[*Cement.*]

Cement shall be made of the best quality of hydraulic lime, and clean, sharp sand, in such proportions (not more than two of sand to one of hydraulic lime), and made in such manner as may be required by said engineer; and the ver-

tical joints shall be well filled with grout made of similar materials, and subject to the same rules as above specified for mortar. The grout to be made of mortar as above described, and filled into every vertical joint of such course as often as ten feet thereof shall be laid. Spalls shall be filled in all the spaces immediately after the grouting is in.

The work shall be kept wet, and free from all dirt.

No cement shall be used in any part of the masonry until the said engineer shall have examined, tried and approved the same. The cement shall be delivered in tight casks.

The engineer shall have the power to remove from off the work, or to destroy at the expense of the contractor all materials which he shall deem unsuitable for the work.

The engineer shall direct in what manner the sand shall be screened and worked.

[*Method of Carrying up the Masonry.*]

The work to be laid up in regular courses, and in no case shall there be more than two unfinished courses.

The face and other stone shall be properly fitted to their places and then raised, and, after the mortar is laid on, lowered to their beds so as to insure a uniform mortar joint. Such machinery shall be used in handling the stone about and on the walls as will enable the workmen to properly lay them, and also to prevent their disturbing or moving the wall that may have been laid, and all face stone shall be placed in the wall by means of a lewis.

6. Concrete Masonry.

Shall be composed of clean, coarse gravel, or of fine broken stones, with hydraulic cement in such proportions as said engineer shall direct.

7. Second Flooring.

Of seasoned two-inch first quality white pine plank, to be well jointed and laid on the foundation between the walls, from the breast wall to the lower end of the main wall, to be close and firmly jointed to the miter sill and walls, so as to make a water-tight flooring.

The plank to butt or the end joints to come to the center of a foundation timber, and each plank to be well treenailed or spiked to the foundation as the engineer may direct.

8. Gates.

The lower gates are to be constructed on the old plan of miter gates with balance beams. The upper one is to be a single gate, inserted at right angles to the lock,

standing nearly upright when closed, and resting on the platform when open. On the lower side is the quoin sill, which sets in a hollow beam on the upper gate platform above described. On each end of the quoin sill to gate are to be cast iron journals, working in cast iron boxes properly secured to the wall. This gate is to be opened and closed by chains running over pullies to a drum on an end of a shaft, which is operated by a lever wheel connected with said shaft by suitable gearing, inserted in a cast-iron frame standing on the coping of the lock.

The framing to be made of the best quality white oak timber, well planed; the cross bars to be framed into the heel and toe post with double tenons; each tenon to be 7 inches long, and the width equal to the thickness of bar, and secured with wrought iron T's well bolted.

The heel and toe posts shall be framed to the balance beam by double tenons, and secured by a wrought iron strap and balance rod, from the top of the beams to the under side of the upper bar.

The lower end of the heel posts to be banded with wrought iron bands; the collar and other hangings to be of wrought iron, secured together with a double nut and screw, and to the coping by bedding the depth of the iron in, and by screw bolts well fastened with sulphur and sand cement.

The pivots, sockets, boxes and journals to be of the very best quality of cast iron, well chilled.

The wrought or malleable iron used shall be the first quality American, Swedish or Russia iron.

The form and dimensions of the timber and iron shall be agreeable to the directions of the aforesaid engineer.

The balance beams, and part of the gates above the upper level, together with the fixtures for opening gates and valves, to be painted with three coats of oil and white lead, and the iron work to be painted black.

The gates to be planked with seasoned, first quality two-inch white pine plank, well jointed, grooved and tongued; the tongues to be made of white oak.

The plank to be secured by 6-inch pressed spike.

On the chamber side of the gates fenders of white oak plank or scantling are to be put on with pressed spike.

A suitable foot-bridge to be put across the lock below the lower gates, in such form and manner as said engineer may direct.

9. Embankments.

The bank to be 20 feet wide on top and have a slope on the outside of two horizontal and one vertical, and finished level with the top of the walls.

The embankment for two feet next the walls of the lock, for 4 feet deep, shall be stone, except a distance of twenty-eight and one-half feet at the head, where it shall be embanked with well puddled gravel 3 feet in thickness the whole height of the wall; and 2 feet in depth of the whole top of the bank shall be clean, hard gravel.

In the progress of the work the embankments shall be kept one foot below the unfinished wall. It shall extend from the head of the vertical wall to the lower end of the apron, descending properly to the lower level.

At the head of the lock and other places the material shall be assorted and put in as may be directed by the aforesaid engineer.

The rules for estimating excavation and embankment shall be according to the sectional specification hereunto annexed; and any portion of the canal which may be added to this contract shall be constructed according to the plan contemplated in the said specification.

10. Snubbing Posts.

There shall be six white oak snubbing posts at each lock of such dimensions, and placed in such positions as said engineer may direct.

11. Foundation Wall.

Under the lock walls if necessary, and at such other places as may be directed, a rubble foundation wall shall be constructed to give a firm and uniform support to the foundation timbers. The walls shall be composed of sound, well shaped and durable stone; the front and rear stone laid in hydraulic mortar, and the interior filled with grout. Suitable bond stone shall be used to firmly connect the wall; and, when directed, the bond shall be well secured by inserting timbers or plank.

12. Explanations.

12. For a more full and perfect explanation of the form and dimensions of materials and parts, and of the manner of constructing the locks in all their details, plans, with bills of timber, will be furnished by the aforesaid engineer; who will also give such directions from time to time, during the progress of the work, as may appear to him necessary and proper, in order to make the work in every respect complete and perfect, on the plan contemplated in the above specifications.

And the said plans and erections shall, in every respect, be complied with.

Lock Specification.

For.....Canal.

GENERAL DESCRIPTION FOR A LOCK OF TWO FEET LIFT.

Locks to be composed of hydraulic stone masonry, placed on a foundation of timber and plank.

The chamber to be 18 feet wide at the surface of the water in the lower level, and 110 feet long between the upper and lower gate quoins.

The side walls to extend 19 feet 7 inches above the upper gate quoins, and thirteen and three-fourths feet below the lower gate quoins. The side walls at the head to be terminated with rectangular wing buttresses; and at the foot with straight wings 25 feet in length, slightly curved at their connection with main walls, and spreading each side at the end 5 feet wider than bottom line of lock walls. In cases where two or more locks shall be combined, culverts formed of large stone cut to one-fourth of an inch joint to pass the water from lock to lock, shall be constructed in the walls with proper apertures for valves, rods and ventilators; and such modification shall be made in form and dimensions of walls as the engineer in charge of the work shall direct.

1. Lock Pit.

To be excavated of such length, width, depth and slope as may be required by the engineer, and the bottom made smooth and level, so as to give a firm and uniform bearing to the foundation timbers.

The earth or rock excavated from the pit to be deposited so as to form as large a portion of the lock embankment as the engineer may direct.

2. Foundation.

Should the bottom be of earth, which in the opinion of the engineer would not be sufficient to support the foundation, then bearing piles of hard wood not less than 10 inches in diameter at the small end, and of such length as may be required to be driven as described below, to support the foundation.

The piles to be driven with a hammer weighing not less than 1600 lbs., and raised as high as may be with leaders 35 feet long.

There shall be four rows of piles under each main wall, and one row in the center of the lock. The piles to be driven in rows, at 3 feet from center to center, except when otherwise directed by the engineer.

The piles to support the wing and breast walls, and wing buttresses, and also under the miter sills to be driven in rows to conform to the form and shape of the same. The heads of the piles to be cut off smooth and level to receive the foundation timbers. The piles to be paid for as delivered for the amount contained in bill furnished by the engineer, and to be paid for as driven, for the amount which the piles may measure after being prepared to receive the foundation timbers. The foundation timbers to be 12 inches square, and of such lengths as will extend from and cover the outside piles, and to be treenailed with a two-inch white oak or white elm treenail, or with iron bolts 24 inches long in each pile.

Should the bottom be of earth sufficiently compact and firm to support the foundation without bearing piles, then the foundation to be composed of timber 12 inches thick, and not less than 10 inches wide, counterhewed on the upper side, and averaging 12 inches wide; to be placed at uniform distances according to their width, so as to occupy or cover at least three-fourths of the area of the foundation, and under the lower miter sill to be placed side by side; in all cases to be of sufficient length to extend across the lock to the back lines of the center buttresses, and at the head and foot of the lock to the rear or back line of the wing walls.

The timbers under the lower miter sill to be white oak, white elm or red beach; and the other foundation and apron timbers to be of hemlock.

The foundation to be extended 3 feet above the face of the main wall at the head of the lock; and at the foot 6 inches below end of wing walls.

The length of the foundation, exclusive of the apron at the foot, to be 173 feet 3 inches.

That portion of the spaces between the timbers in all cases to be filled with concrete masonry, as the engineer may direct.

In cases where rock may compose the bottom of the lock, the foundation timbers, if required, to be 10 inches thick under the lower miter sill, 8 inches thick at other places, and placed at such distances apart as may be directed, and laid in hydraulic mortar. The spaces between the timbers, so far as may be necessary, to be filled with rubble, hydraulic or concrete masonry. Should the rock be of such a character as not to require timber in the foundation, the same to be excavated smooth and level, and

the first course of stone well fitted to the rock, without any extra charge for the same.

[*Apron.*]

If necessary an apron not to extend less than 30 feet below the lower end of wing walls, and to be constructed of timber laid parallel with the other foundation timbers, the whole to extend under the vertical walls and be covered with 2-inch hemlock plank, or it may be composed of quarried stone pavement, set up edgewise 18 inches deep, as the engineer shall direct.

[*Sheet Piling.*]

In all cases where rock does not occur, a course of piling to be located at the head of the foundation under each set of gates at the lower end of the wings, and at the lower end of the apron to be from 4 to 6 feet deep, as may be required. In each case to extend across the whole foundation.

The sheet piling to be of 2-inch hemlock plank, lined with 1-inch pine boards. Ditches to be excavated to receive the sheet piling, which are to be placed edge to edge, and the top well secured by spikes to the foundation timber. The spaces excavated as above to be filled up with fine, hard gravel, well puddled in, or with concrete, so as to render the work impervious to water.

[*Flooring.*]

A course of two and one-half inch pine or hemlock plank to be laid over the whole of the foundation timbers, except a space of 3 feet wide under the face line of each wall, which shall be covered with two and one-half inch white oak plank; the whole to be well jointed, and every plank well treenailed with two white oak treenails at each end, and at every three feet in length to enter the timber at least five inches, or with wrought iron spikes, as the engineer may direct; the treenails to fill one and one-fourth bore.

The floor plank in the chamber of the lock and other parts where a lining course is to be laid, and for three feet under the walls, to be sized true and even to form a close and uniform support to the lining plank. On this floor the superstructure is to be erected.

3. Platform for Upper Gate and Valves.

To consist of a frame work of timber extending across the lock and raised to within two feet nine inches of canal bottom of upper level. In this platform the

valves are to be inserted. They will lie horizontally when closed and will be operated by levers, rods and shackle bars from the side of the lock. On this platform a tumble or drop gate is to be erected, all to be according to the plans and directions of the engineer.

4. Miter Sills.

To be of best white oak timber 9 inches thick, and of such length and width as may be directed by the engineer. Each sill to be well jointed and bolted to the foundation or platform timbers, with 9 bolts of iron 20 inches long and one inch square, well ragged and headed.

5. Masonry.

The main walls for 17 feet 6 inches in length from the wing buttresses at the head, and 33 feet 3 inches of the lower end to be 9 feet 10 and three-eights inches thick, including the recesses, and for the intermediate space to be 7 feet ten and three-eights inches thick, with three buttresses projecting back two and one-half feet and 9 feet long, placed at equal distances apart, leaving spaces of 16 feet between them, and to have an offset of 6 inches in thickness at 5 feet below the top. At two and one-half feet below the top of the walls the buttresses are to terminate; and at 4 feet below the top such offsets made in other parts of the walls as will leave them, after allowing for the inside batter and one foot for the outside batter, the coping width at the top. The height of the wall to be twenty and three-fourths feet.

The walls of the chamber each to have a batter on the face of one-half inch per foot rise to the top of the wall. The same batter to be made in the walls, from the lower hollow quoin to the ends of the wings. The nose of the quoins to be placed in line of chamber, and to curve on an increased radius so as to conform to the batter.

[*Quoins.*]

The quoin stones in which the heel posts are to rest, to be not less than four and one-half feet in length in the line of the chamber, and be cut and formed to a curve of seven inches radius; the nose to be rounded on a radius of three and sixty-six one-hundredths inches, and the heel beveled to the rear of the recess. The quoin stones to be alternately header and stretcher.

[*Recesses.*]

The recesses for the lower gates to be 20 inches deep at the top of the wall and 12 feet long, with sub-recesses 9 inches deep, 6 feet high and 10 feet long for the gate valves.

The ends of the recesses opposite the quoin to be finished for a miter bevel.

The recesses for the upper gate to be of such form and dimensions as may be required for the insertion of a tumble gate.

Wing buttresses at the head of the lock to be 3 feet thick, and to extend on the bottom to the upper edge of foundation, and to be carried plumb to the whole height of the main wall.

Breast wall to commence five and one-fourth feet below the upper end of the foundation, and extend across from side wall to side wall, to be 5 feet wide and 11 feet high, finished with a coping of cut stone.

[*Wing Walls.*]

The wing walls, at the point where they join the main walls, to be 7 feet ten and three-eighths inches thick, and at the ends 6 feet 7 inches thick on the foundation. At 4 feet below the top of the walls an offset is to be made, which, after allowing one foot for the batter on the rear of wall, shall leave the coping width of feet at the top.

[*Character of the Work.*]

The face stone of the masonry to be of gray or blue limestone, of sound and good quality, to be cut true and even; the upper and lower beds to be parallel; the cutting to be done and the work laid with a mortar joint not to exceed in any place one-fourth of an inch in thickness, excepting that part of the vertical joint beginning 12 inches from the face of the wall and extending to the rear of the face stone, which shall not exceed an average of one inch in thickness.

The lowest course of face stone to be not less than 18 inches, and the second course not less than 30 inches wide on top. The second course in all places to break joints at least 12 inches on the backing, immediately in the rear of the face stone below it, and to have a header two and one-half feet long on the face, extending back into the wall at least four and one-half feet, one in every 10 feet in length of wall; every succeeding course of masonry to have like headers therein so laid that in alternate courses they will be intermediate to each other.

The face of the wall to be made of such alternate courses to the coping.

No course of face stone to be less than 12 nor more than 30 inches in thickness. Should any course exceed 18 inches in thickness it must have as much bed as height. Each stone in every course to break joints at least one foot with the stone on which it may rest.

The backing to be of any stone of sound and good quality, which the engineer may approve; to be laid in courses with similar headers in each course, placed intermediate to the headers from the front. The backing in no case to rise higher than the face in any course of masonry, and no dressing of stone will be permitted after they shall have been laid into the work. The bed joints in the backing not to exceed one inch in thickness in any place, and the vertical joints not to exceed an average of two inches; but the backing stone must be in contact in some places at the beds and vertical joints, and especially with the rear of the face stone. The backing stone shall break joints at least 6 inches, and no stone shall be less than 6 inches in thickness nor have less than four square feet of surface.

[*Coping.*]

All the walls to be coped with cut stone. At the head of the lock, at the recess and quoin corners, and for a suitable distance above and below the recesses the coping stone to be 5 feet wide on the top; at the recesses 3 feet 4 inches wide; on the chamber walls 4 feet wide; and on the wing walls 3 feet wide. All the coping to be not less than 15 inches thick and uniform in thickness, and to increase in width downwards from the top, to conform to the batter on the wall. The length of each coping stone to be equal to the breadth of the course.

At the head and foot of lock the coping to be secured by dowel bolts of iron, and two clamps to each joint; and from the head to the second joint below the lower recess each coping joint to be secured with two clamps of iron, each to be 9 inches long, two inches wide and five-eighths of an inch thick, and countersunk into the wall so as to be level with the coping.

The bolts and clamps to be well secured by a cement made of sulphur and sand, in such proportion as may be directed by the engineer.

The inside upper corner of the coping of the lock to be finished with a nosing of three inches radius; in other respects the stones to be cut to a straight line on all sides.

[*Cement.*]

To be made of the best quality of hydraulic lime and clean, sharp sand, in such proportions and made in such manner as may be required by the engineer; the vertical joints to be well filled with grout made of similar materials, and subject to the same rules as above specified for mortar. The grout to be made of mortar, well filled into every vertical joint of each course as often as ten feet

thereof shall have been laid. Spalls to be filled in all the spaces immediately after putting in the grout.

The work to be kept wet and free from all dirt.

No cement shall be used in any part of the masonry until the said engineer shall have examined, tried and approved the same. It must be delivered in tight casks.

The engineer shall have the power to remove from off the work, or to destroy, at the expense of the contractor, all meterials which shall be deemed unsuitable.

The engineer to direct in what manner the sand shall be screened and worked.

[*Method of Carrying up the Masonry.*]

The work to be laid up in regular courses, and in no case shall there be more than two unfinished courses.

The face and other stone to be properly fitted to their places and then raised, and after the mortar shall have been laid on lowered to their beds so as to insure a uniform joint. Such machinery to be used in handling the stone about and on the walls, as will enable the workmen to properly lay them, and also to prevent their disturbing or moving the wall that may have been laid, and face stone shall be placed in the wall by means of a lewis.

6. Concrete Masonry.

To be composed of clean, coarse gravel, or of fine broken stone, with hydraulic cement in such proportions as the engineer may direct.

7. Second Flooring.

Of seasoned 2-inch first quality white pine plank, to be well jointed and laid on the foundation between the walls, from the breast wall to the lower end of the main wall, to be close and firmly jointed to the miter sill an walls, so as to make water tight flooring.

The plank to butt, or the end joints to come to the center of a foundation timber, and each plank to be well tree-nailed or spiked to the foundation, as the engineer may direct.

8. Gates.

The lower gates to be constructed on the old plan of miter gates with balance beams. The upper one to be a single gate, inserted at right angles to the lock, standing nearly upright when closed, and resting on the platform when open. On the lower side will rest the quoin sill, set in a hollow beam on the upper gate platform above described. On each end of the quoin sill to gate are to be cast iron journals, working in cast iron boxes properly

secured to the walls. The gate to be opened and closed by chains running over pulleys to a drum, on the end of a shaft operated by a lever wheel connected by a suitable gearing, and inserted in a cast iron frame standing on the coping of the lock.

The framing to be made of the best quality of white oak timber, well planed; the cross bars to be framed into the heel and toe posts with double tenons; each tenon to be 7 inches long, and the width equal to the thickness of the bar, and secured with wrought iron T's well bolted.

The heel and toe posts to be framed to the balance beam by double tenions; and secured by a wrought iron strap and balance rod, from the top of the beam to the under side of the upper bar.

The upper end of the heel posts to be banded with wrought iron bands; the collar and other hangings to be wrought iron, secured together with a double nut and screw, and countersunk in the coping, the whole being secured by a screw bolt well fastened by sulphur and sand cement.

The pivots, sockets, boxes and journals to be of cast iron, well chilled.

The wrought or malleable iron used to be of the first quality of American, Swedish or Russia iron.

The form and dimensions of the timber and iron to be agreeable to the direction of the engineer.

The balance beams and part of the gates above the upper level, together with the fixtures for opening gates and valves, to be painted with three coats of oil and white lead, and the iron work painted black.

The gates to be planked with seasoned, first quality 2-inch white pine plank, well jointed, and secured by a 6-inch pressed spike.

On the chamber side of the gates fenders of white oak plank or scantling to be put on with pressed spike; a suitable foot-bridge to be put across the lock below the lower gates, in such form and manner as the engineer may direct.

9. Embankments.

The bank to be 20 feet wide on top with a slope on the outside of two horizontal to one vertical, and to be finished level with the top of the walls.

For two feet next the walls of the lock the embankment for 4 feet deep shall be stone, except for a distance of twenty-eight and one-half feet at the head, where it shall be made of well puddled gravel 3 feet in thickness, the whole height of the wall; and 2 feet in depth of the whole top of the banks shall be clean, hard gravel.

In the progress of the work the embankments to be kept one foot below the unfinished wall. It shall extend from the head of the vertical wall to the lower end of the apron, descending properly to the lower level.

At the head of the lock and other places the materials to be assorted and put in as may be directed by the engineer.

The rules for estimating excavation and embankment to be according to the section specification hereunto annexed; and any portion of the canal which may be added to this contract, to be constructed according to the plans contemplated in the said section specification.

10. Snubbing Posts.

Six white oak snubbing posts to be provided, of such dimensions and placed in such positions as the engineer may direct.

11. Under the lock walls, if necessary, and at such other places as may be directed, a rubble foundation wall to be constructed, to give a firm and uniform support to the foundation timbers. The wall to be composed of sound, well shaped and durable stone; the front and rear stone to be laid in hydraulic mortar, and the interior filled with grout. Suitable bond stone to be used to firmly connect the wall; and when directed the bond to be well secured by inserting timbers or plank.

12. For a more and perfect explanation of the form and dimensions of materials and parts, and of the manner of constructing the locks in all their details, plans, with bills of timber, will be furnished by the division engineer; who will also give such directions from time to time, during the progress of the work, as may appear to him necessary and proper, in order to make it in every respect complete and perfect, on the plan contemplated in the above specifications.

And the said plans and directions shall, in every respect, be complied with.

Aqueducts.

GENERAL SPECIFICATION.

The aqueducts are to be composed of abutments with wing walls and piers of substantial masonry, on which a trunk of timber and plank for the prism of the canal is to be placed. The trunk of the aqueduct, when not otherwise directed, to be thirty feet wide and five and one-half feet deep. The whole, except where rock occurs, to rest on a foundation of timber and plank; when required by the resident engineer in charge of the work, bearing piles to be driven to support and protect the foundation.

1. The foundation pit to be excavated of such form and dimensions, and the earth from the same to be deposited as may be required by said engineer, and the bottom made smooth and even, to give a firm and uniform support to the foundation. Should the material be removed 200 feet from the place excavated, and be deposited in a necessary bank, it shall be estimated both as excavation and embankment.

2. Should the ground on which it is to be placed be such as to require bearing piles, the same shall be driven and secured to the foundation timbers, as the engineer may direct. The foundation to be composed of hemlock timber from ten to twelve inches thick, and not less than twelve inches in width, covered with hemlock plank from two to three inches thick, as may be required; the plank to be well treenailed to the timbers with treenails seven inches long for two-inch plank, and eight inches long for three-inch plank; at the end of each plank and every three feet intermediate, there shall be two treenails for planks of ordinary width, and a corresponding increase in number for those of greater width. Should rock be found in the foundation, then the timber and plank to be wholly or in part dispensed with, or varied in dimensions, as may be directed by said engineer. In cases where it may be required, the foundation to extend over and cover the spaces between the abutments and piers. A course of sheet piling from four to six feet long to be inserted along the upper and lower sides of the foundation, and at such other parts as may be directed. The manner of putting them down shall be by excavating a ditch to the depth of the sheet piling, placing the plank

edge to edge and spiking the head to the foundation timbers, so as to render the work close and substantial. Except when otherwise directed, a lining course of one-inch boards shall be laid over the plank, so as to break joints with them and be secured by nails. Where the gravel or other earth may be liable to be washed by floods, so as to fill or obstruct the channel for the passage of water under the aqueduct, a breast or dam of suitable masonry to be carried up at the head or upper side of foundation, in such a manner as may be directed; the fall over such dam or breast to be protected by a second course of planking, either level or inclined, as may be determined; and if said engineer shall direct other structures of a similar character to be located at points further up the stream, and in all cases to be well guarded against injury from floods. The spaces between foundation timbers and each side of sheet piling and above breast wall to be filled with fine, clean gravel well puddled in, or with concrete, as may be directed.

3. The front faces of the abutments and side faces of the piers to be carried plumb in aqueducts of ordinary height and exposure, but those over large streams to be battered, and have such recesses as may be directed. The ends of the piers to be battered from one-twelfth to one-ninth their rise; and in cases where it may be directed by said engineer the upper ends of the piers to have a suitable slope from the foundation for ice-breakers, which shall be coped with stone at least one foot in thickness, and have a length equal to the thickness of the pier, and if required to be well secured with iron bolts in such manner as may be directed. The wing walls to have a batter on the face of one-twelfth the height, and if necessary suitable pilasters to be carried up on the face of the wing walls. A buttress shall be formed at the exterior end projecting one foot in the front, and in the rear from one to four feet beyond the wing wall, as may be directed by said engineer. In the rear near the center of the wing there shall be a buttress four feet thick, projecting from four to six feet back from the wing. The rear of the abutment and wings between the center buttress to have a batter of one to six. That part of the abutments covered by the trunk to be five feet thick at the bottom of the canal, and that part which is carried to or near the top bank level to be three feet thick on the top, and increase in thickness towards the foundation by the batter above mentioned, and also by an offset of one foot on the rear, at every six feet down to the level of canal bottom.

The wings to be three feet thick on the top, and increase

downwards by the batter, and at the bottom level of the canal by an offset of one foot on the rear, and a similar offset at every six feet down corresponding with the offsets in the abutments. The piers to be from four to six feet thick, and the top finishing of all the masonry to be a coping of cut stone not less than nine inches deep. That part of the abutments and piers under the trunk to have a course of coping alternately crossing the wall and meeting in the center, from each side of the walls when required. The spaces between the floor timbers to be filled with rubble masonry. The remainder of the abutments and wings to be coped with stone extending across the wall and projecting forward to three inches over the face, and be not less than three feet wide in the direction of the wall. A recess for the toe of the braces to be cut when directed by the said engineer.

The masonry to be formed of sound, well-shaped and durable stone, and laid in courses not less than nine inches thick. The face stone to be dressed to one-half of an inch joint on the beds for the whole breadth of bed, and on the ends twelve inches one foot back from the face. The stretchers to have a breadth of bed equal to the thickness or depth of the course, and in no case less than eighteen inches; and the breadth from the front to the rear of the headers to be in no case less than two-thirds the thickness of the wall. One-fourth of the wall in front and rear of each course to be occupied with headers arranged on both sides to give the greatest stability to the work. In the larger aqueducts one-third of the headers, or at least one-twelfth of the stone in each course to extend through the piers at each end. The ends of the piers to be formed of one stone that shall fill the course, and be at least three feet long; and the next course of two stones that shall make the width of the pier and be at least four feet long, the ends to be composed of such alternate courses to the top. The same or larger sized stone shall be used in the courses of the abutments at upper side of aqueduct. The upper courses of coping to the breast and ice-breaker to be carefully beveled or rounded off, as may be directed. Where ice-breakers are to be constructed this kind of work will not be required below the top of the same.

The backing and interior wall to be composed of large and well-shaped stone, and in no case to be less than six inches thick, and three feet area of bed so laid as to form a good bond. The lower beds to be dressed level and even, and all high projecting points to be hammered off from the top beds, so as to give the succeeding stones a firm bearing. In all cases the beds to be properly prepared

by leveling up before laying the next stone; but no lever shall be placed under a stone by raising it from its bed.

All the stone to be well bedded in mortar made of the best hydraulic lime and clean, sharp sand, and in such proportions not more than two parts of sand to one of lime, as the said engineer may direct; the vertical joints to be grouted with similar materials and be subject to the same directions; each course, as far as laid, to be grouted fully before commencing another, and spalls to be filled in all the spaces after they shall have been well grouted. The masonry to be carried up in regular courses, and during its progress the work shall, at no time, have more than two unfinished courses. The stone to be kept wet and free from all dirt; no dressing shall be done upon a stone after it shall have been laid, and no cement shall be used without having been examined and approved by the engineer. Where rock dressed masonry may be required, a draft about one inch wide around the edge of each face stone shall be cut, and the rock projection shall not exceed three inches. When rock dressed masonry shall not be required the front of the wall to be dressed to a smooth and even surface.

4. The trunk to be composed of white oak or white pine string timbers, of such dimensions and placed at such distances apart as may be directed by the said engineer. The two outside stringers to be placed so as to embrace the side post tenons, and give them a firm support. The side posts to be white pine or white oak timber eight by eight inches at the top, and eight by fourteen at the bottom shoulder, and placed three feet from center to center, the corner or end posts to be white oak; a white pine plate ten by eighteen inches to be framed on the top of posts. The bottom of the trunk and the ends of the floor timbers in the abutments to be covered with a course of 2-inch white pine plank of a good quality to make water tight joints, the whole to be free from shakes and unsound knots; and to be well treenailed to the foundation timbers with treenails six inches long, of suitable size to fill an aperture one inch in diameter. The sides to be planked with 3-inch white pine plank of suitable quality, grooved and tongued as may be directed and secured to side posts with treenails seven inches long, of suitable size to fill an aperture one inch in diameter. If required the sides and bottom of the trunk are to be braced from recesses to be cut in the masonry in such manner as may be directed.

5. For a more full and perfect explanation of the form and dimensions of materials and parts, and of the manner of constructing the aqueducts in all their details, plans, with bills of timber and iron, will be furnished by the said engineer who will also give such directions from time to time during the progress of the work as may appear to him necessary and proper, in order to make it in every respect complete and perfect on the plan contemplated in the above specifications. And the said plans, bills of timber and iron and directions shall, in every respect, be complied with.

Bridge Abutments of Masonry for Canals.

GENERAL SPECIFICATION.

To prepare for the construction of the abutments such excavation to be made and puddle wall or other support provided as may be necessary to allow suitable foundations of timber and plank to be put down. The masonry to commence at canal bottom on the berme side, and from 3 to 5 feet above on the towing path, or at such other elevation as may be required for the security of the bridge, to be determined by the engineer.

Each foundation to be composed of pine or hemlock timber not less than 10 inches wide and 9 inches thick, laid longitudinally with the abutments, and at such distances apart as may be directed. The spaces between the timbers to be filled with clear gravel, well puddled, or with concrete; the whole to be covered with a course of 2-inch pine or hemlock plank and, if required, the foundation to be protected by sheet piling.

The abutments and wings to be constructed of substantial masonry, and to be generally located 72 feet apart between the bridge seats, the height of which are to be 18 feet above the canal bottom.

Each abutment to have a face batter of one inch to the foot, a thickness of three feet on top, and in 4 feet from that point a rear batter of one foot and an offset of 6 inches, the rest of the wall being carried plumb to the foundation. The length of the abutments to be governed by the width of superstructure required, but in all cases to extend not less than 18 inches beyond each outer side of the truss.

Each wing to be 12 feet long with a flare of 4 feet, a face batter of 1 inch per foot, a thickness of 3 feet on top at the abutments, and at 2 and one-half feet at the ends, the rear of the masonry being plumb throughout. The upper part of the wings to commence level with the roadway, and from that point down to have steps of uniform rise cut to conform to the slopes of the embankments. At the rear of the wings is to be placed a curbstone 4 inches thick, for the purpose of keeping the earth from the steps.

The masonry to be of sound, well-shaped and durable quarry stone, laid in regular courses of not less than 9 inches in thickness. The stretcher to have a breadth of bed one and a half times the depth of course, but in no

case less than 18 inches, and the headers a breadth of bed two and one-half times the depth of course, and in no case less than 3 feet. One-fourth of the wall in front and rear to be occupied with headers so arranged that the headers of one course shall come between the headers of contiguous courses, and those in front be at a medium distance between those of the same course in the rear.

The face stone to be dressed to one-fourth of an inch joint for 12 inches back, and to have joints not exceeding half an inch for the balance of the bed. The end joints to be one-fourth of an inch for 9 inches back from face, and the balance to fall off at an angle of 22 and one-half degrees.

The face of the masonry to be rock-dressed with a draft or arris around each stone, and the projecting points to be not more than two inches.

The backing to be of large sized stone, and laid in courses corresponding with those in the face; but two courses may fill up one of face, provided no stone be used less than 6 inches thick. The beds of the backing to be dressed off so as to have a good bearing on the stone below, and in all cases the broadest bed to be laid down, and should any leveling be necessary on the upper bed it shall be done before laying the other stone, but at least two-thirds of the upper bed shall be the full thickness of course, so as to give the next stone a firm bearing upon it, and no levers or spalls put under the stone will be allowed to raise it from its bed.

The stone to be well bedded in mortar made of the best quality of hydraulic lime, and clear, sharp sand mixed in such proportions as may be directed, and no cement to be used before being examined and approved by the engineer in charge.

All the joints of masonry in each course to be grouted with similar materials before commencing to lay another, and only after grouting will any spalls be allowed to fill up the spaces between the backing and the face stone.

The top of the walls to be coped with cut stone not less than 10 inches thick, three and one-sixth feet wide and three feet long laid to project 2 inches over the face of the wall, and lined to receive the timber work of the bridge.

All the face stone to form a bond of at least 9 inches with each other, and a bond of 6 inches with the backing, and the backing to have bonds of at least 6 inches.

The masonry to be laid up between the first of April and the middle of October, unless otherwise directed by said engineer.

When required a stop gate to be built, connected with the abutment of the bridge in the following manner:

A foundation of timber and plank 21 feet wide to be laid across the bottom of canal from the rear of the berme abutment to a point nearly under the front angle of towing path; the top of plank to be 10 inches below bottom of canal.

The timbers to be laid at right angles to the canal, and properly secured in the center by anchor timbers and ties sunk in the ground 4 feet, or by bearing piles. On one end of this foundation the berme abutment is to rest, and on the other is to be built a vertical wall laid in mortar.

Three rows of sheet piling not less than four feet in length are to be driven, one in the center and one on each side of the foundation, the center course being extended five feet each way beyond the other two.

On the top of the first floor are to be placed three timbers 10 by 12 inches, one in the center and one on each side properly secured to the foundation, extending one foot into each wall and tied together in the center with suitable cross-pieces.

Between these timbers a lining course of 2-inch plank is to be laid, well secured by treenails or spikes.

At or near top water line and over center of foundation are to be suitable recesses left in the abutment and vertical wall for receiving a movable breast timber 12 inches square, against which and the center timber on top of foundation are to be placed two courses of movable 2-inch plank, breaking joints over each other to form the dam; the plank to be placed on either side of the timber as the occasion may require.

In the rear of the breast timber two movable braces are to be placed at equal distances between the abutment and vertical wall, and to be framed against the outside timber on foundation in such manner as to firmly brace the dam.

The breast timber is to have a chain attached at each end for the purpose of handling, and of securing it to the embankment when not in use.

For holding the plank and braces of the dam a box of suitable dimensions is to be made of 2-inch plank, well put together with a door in one end well secured with wrought iron fastenings, as may be required.

The embankment in rear of abutment and vertical wall is to be of good material and well puddled in to 8 feet high above bottom of canal, so as to effectually prevent the water from endangering the structure.

River Dams.

SPECIFICATION OF THE MANNER OF CONSTRUCTING A CANAL.

GENERAL DESCRIPTION.

A dam to be composed of hydraulic stone masonry placed upon the rock in bed of river, or if necessary on a foundation of timber and plank with abutments and wings on both sides of river, and if required a suitable bulk head to be constructed for the hydraulic power on south side of river.

The dam to be.....feet in length and about seven feet in height. The top or waste of dam to be of such height as may be necessary to make seven feet depth of water in the canal, and the abutments to be at least two feet above high water mark.

1. PRELIMIINARY.

The bed of the river to have all the gravel, stone and other loose material removed and the rock excavated, so as to make smooth, sound botto'n as far as may be required, the material moved to be deposited as may be directed. The abutment pit to be excavated to the rock if required, and the material deposited in necessary bank. Suitable pits shall be excavated for all vertical or slope wall which may be required.

2. FOUNDATION.

The masonry to be commenced on the rock in the bed of the river, when in the opinion of the engineer in charge of the work it shall be of a character sufficient for that purpose. If required in any part of the dam a foundation of timber or of timber and plank shall be placed upon the rock of such form and plan as the said engineer may direct, and be properly secured to the rock and all spaces between it, and the timber shall be filled with concrete masonry.

If required an apron of timber to be laid below the dam not less than.....feet in length, and properly secured to the rock by bolts not less than one inch in diameter, and fastened with fox wedges. The plan of this apron shall be according to the direction of the engineer. All spaces to be filled with concrete masonry or grout.

3. Masonry in Dam.

The wall or dam to be eight feet thick at the top measured on a horizontal line, and to increase in thickness by a batter on the lower side of two inches to a foot and by a batter on the upper side of four inches to a foot, making the wall 11 feet two inches thick at seven feet below top of coping. The coping to be laid with one foot inclination on its bed; to be not less than 20 inches in thickness dressed in front and rear; to conform to the bevels of the dam the front and top to be cut true and even, and have a nose of 3-inch radius on the top angle.

The coping to cover the full thickness of the wall and to be not less than three feet wide lengthwise of dam; each stone to be bolted to the wall below with three wrought iron bolts of not less than one inch and a quarter in diameter, and of such length as to enter the second course of stone below at least six inches to be secured with a fox wedge at the bottom, and with sulphur and sand cement. Each piece of coping to be clamped with two clamps ten inches long, their ends entering the stone at least three inches and their tops let in even with surface of stone, the spaces to be filled with sulphur and sand cement. The expense of cutting in clamps and drilling holes for bolts to be included in other prices.

The top course of masonry under the coping to have a bevel from front to rear cut true and even to receive the coping as represented on the plan.

The coping to abutments and wings to be bolted to the masonry beneath with wrought iron bolts of such length as to extend into the wall below at least one foot band, also be clamped together. The form of abutments and wings to be according to the plan of the engineer.

The face stone of the masonry to be composed of blue or gray limestone of sound and good quality, laid in regular courses of not less than 12 inches in thickness, the upper and lower bed to be parallel except the top bed of the course under the coping of the dam, which is to receive the bevel or inclination above mentioned. The face in the abutments and dam (excepting the coping) to be cut and laid with a mortar joint not exceeding in any place one-half of an inch in thickness, excepting that part of the vertical joint beginning twelve inches back from the face of the wall, which shall not exceed an average of one inch in thickness.

The lower course of face stone to be not less than twenty-four and the second course not less than 36 inches wide on top bed. The second course in all cases to break joints at least 12 inches on the backing immediately in

rear of the face stone below it, and to have headers of not less than two and one-half feet long on the face, extending back into the wall from four and one-half to six feet and averaging only ten feet apart. Every succeeding course of masonry to have similar headers so laid that in alternate courses they shall be intermediate to each other.

The face stone (except coping to dam) to be rock dressed with a draft or arris around the face, and no point shall project more than one and one-half inches.

The backing to be of similar stone to the face, of sound and good quality and laid in courses with corresponding headers in each course placed intermediate with the headers from the face. The backing in no case to rise higher than the face stone in any course of masonry, and no dressing of stone will be permitted after they shall have been placed in the work. The bed joints in the backing not to exceed one inch in thickness in any place, nor the vertical ones an average of two inches. All the backing to be in contact in some places with the beds and joints, and especially with the rear of the face stone. The backing to break joints at least 8 inches and no stone to be less than 8 inches in thickness, or have less than 4 square feet of surface.

The masonry in abutment and wings to have the dimensions indicated upon the plan, and to be constructed as specified above.

The coping to the dam to be dressed smooth and even on the top and lower face, and cut to one-fourth of an inch bed and joint for the whole length and breadth of each stone. The coping to the abutment and wings to cover the whole width of the walls on top, and to be laid to one-fouth of an inch bed and joint.

The stone for all masonry to be well bedded in mortar made of the best quality of hydraulic cement and clean, sharp sand in such proportion as said engineer shall direct, and the vertical joints grouted with similar materials. Each course to be fully grouted before commencing another.

The work to be kept wet and free from dirt. No cement to be used in any part of the work until said engineer shall have examined, tried and approved the same, and it must be well housed so as to be kept perfectly dry.

The face and other stone to be properly fitted to their places and then raised, and after the mortar is spread lowered to their beds, so as to insure a uniform mortar joint.

Such machinery to be used in handling the stone on and about the walls as will enable the workmen to properly lay them, and also to prevent disturbing or removing the wall that may have been laid.

4. Concrete Masonry.

To be composed of clean, coarse gravel, or of fine broken stone with hydraulic cement, and clean, sharp sand in such proportions as said engineer may direct; to be mixed in a box and then shoveled into the work. The upper angle of dam to have a course of concrete laid on it as represented on the plan; concrete to be used at such other points as the engineer may direct.

5. Filling Above Dam.

After the masonry and concrete above described have been put in, there shall be a filling of loose stone or brush and stone extending up not less tnan 15 feet.

6. Walls.

Vertical or battered walls laid dry or in hydraulic cement resting upon foundations with timber and plank or otherwise shall, when required, be constructed on the inside of the banks of the river and at such places and of such form and dimensions as shall be directed by said engineer.

If required a pavement to be laid on top of embankments in rear of abutment and wings, and paid for as vertical wall in cement.

The section specification annexed provides for the manner of performing and estimating all kinds of wall not herein particularly described, and is considered a part of this contract.

For a more full and perfect explanation of the form and dimensions of all the work, and of the manner of executing it in all its details, plans and bills of timber will be furnished by the said engineer who will also give such directions during the progress of the work as may be necessary to have the same done in every respect complete and perfect on the plan contemplated in the foregoing specification; and the said directions shall, in every respect, be complied with.

Bridges.

SPECIFICATION OF THE MANNER OF CONSTRUCTING WHIPPLE'S PATENT IRON ARCH TRUSS BRIDGE SUPERSTRUCTURES OVER CANALS.

Each superstructure to consist of a plank and timber flooring supported by two or more trusses of wrought and cast iron, and in cases of bridges with sidewalks an iron railing three feet high on the outside of each sidewalk.

The trusses to be composed of cast iron arches and connecting blocks, and wrought iron chords, uprights and diagonals; and the flooring of iron needle beams, pine joists and oak planking, as shown on the plans exhibited at the letting.

The truss arches to consist of straight pieces diverging and widening horizontally from a width of about one-twelfth the length of the piece in the middle to about one-fourth the height of the truss (and rather more in short trusses) at the end of the arch, each widening in proportion as it pitches downward from a horizontal position. In trusses from 55 to 75 feet in length the arch is to contain 7 pieces meeting at angles of 82 degrees, the ends being beveled 4 degrees so as to form a joint, with a deflection of 8 degrees from one piece to the next contiguous. In trusses from 75 to 100 feet in length the arch is to contain 9 pieces with ends beveled 3 degrees at the joints, giving 6 degrees angle of deflection from piece to piece, or such other angle of deflection as may be directed by the resident engineer in charge of the work.

The extremities of the arch are to be formed into feet resting on the abutments with a flat bearing of 11 to 13 inches from heel to toe, and have a firm connection with the ends of the chords by having the endmost links left open at the connection, and after passing through the feet from heel to toe secured by screw nuts at the toe; in which case the portion of the rod where the screw thread is cut is to have at least three-eighths inches greater diameter than the rest of the chord.

The ends of the arch castings at the joints are to be so shaped as to form vertical holes for the uprights to pass through and afford horizontal bearings for the nuts of the uprights on the upper, and for the eyes of the diagonals on the under side, the holes being so placed that the plane of the arch joint may cut the center of the uprights about two inches below the upper side of the castings.

The depth or width of arch castings (towards the center of the general curvature) is to be not less than one-eighteenth the length of the pieces respectively, unless a compensating increase be made in the cross sections of the pieces; which cross sections, multiplied by the natural size of the inclination of the pieces respectively from the vertical, are in all places to give products of not less than one square inch for each 90 square feet of bridge floor supported by the trusses respectively, not including the coping under the trusses and railing, and in trusses supporting less than 10 feet width of flooring each, the cross sections of the arch castings, multiplied as above stated, are to give products of not less than one square inch to every 70 square feet of flooring, and to have not less than half an inch in thickness of iron in any part, and not less than seven-eighths inch in thickness within 3 inches of the joints.

No wedging of the arch joints will be allowed. The ends of the pieces must be planed by machinery or accurately hand dressed, as may be directed by said engineer.

Near the outer or upper corner of the joints are to be projections of about three-fourths of an inch in length and depth and one and one-half to two inches in width cast on one piece, and extending into the angles of the contiguous piece to assist in keeping the ends in place.

Each piece of the arch casting is to have at least 4 cross bars connecting the side portions; the end ones being 5 to 6 inches wide and of a depth at the upright hole not less than one-fifth the width of castings at the point of location; the others at uniform distances between the former, and in section equal to one-third that of the longitudinal parts of the castings.

For the forms and proportions of the cross-bars and for other particulars not here specified, as well as for the better understanding of these specifications generally, reference is had to the drawings and to instructions and directions of the engineer in charge of the work.

The connecting blocks are to be of cast iron; the end portions where the links go on to be about two and one-half inches deep with a cross section nowhere less than 24 times the cross section multiplied by the diameter of the iron in the chords, and divided by the width of the connecting block. The edges of the blocks to be fitted to the semi-circular ends of the links.

The central portion of the block is to be so enlarged as to admit of the holes for the uprights and diagonals, and not allow of being cut or fractured in that part without an area of section or fracture at least 20 per cent. greater

than the cross section of the block where it receives the links of the chords.

The lengths of connecting blocks are to be, for those next the ends of the truss, such that the endmost links of the chord may run parallel from their connections with the feet of the arch and connect on the ends of the block, the next succeeding links being inside of the former, and so on to the middle of the truss with the two links of each pair parallel or nearly so, and the blocks diminishing in length successively by about twice the diameter of the iron in the links.

All the iron to be of such kinds, mixtures and qualities as to produce sound and strong castings, equal to the best descriptions of metal used for machinery.

The ends of the chords and the feet of the arches on the abutments are to be covered with a cast-iron box to protect them from contact with the earth of the approach.

WROUGHT IRON WORK.

The chords to each arch piece are to be composed of two links of such length as to be joined in pairs by the cast-iron connecting blocks directly under the arch joints, and connected with the extremities of the arch in the manner before described. The aggregate cross section of the chord to each truss is to contain not less than one square inch for each 120 square feet of bridge flooring (copings not included) sustained by the truss.

The uprights are to be one at each joint of the arch; the middle ones (and more when required) in each truss to be composed of two rods united into one at the upper end for that portion which passes through the eyes of the diagonals, the arch and the nut on the top; with a collar or ring of seven-eighths inch square, iron welded on just below the eyes of the diagonals, to prevent the latter from sliding down. From 2 to 3 inches below the collar the two rods diverge at an angle of 10 to 12 degrees, and pass through the connecting blocks outside of the chords. The upper end or single portion in these uprights is to be of the same diameter as in the single uprights of the same trusses, and the double portion of one and five-eighths inch iron for sidewalk bridges of spans over 75 feet, and of one and one-half inch iron for all other bridges of less than 100 feet span, unless otherwise directed.

Each branch of the double uprights is to have a nut to bear on the upper side of the iron needle, and another on the under side of the connecting block, the uprights passing through cast iron thimbles or washers intervening between the bottom of the needle beam and connecting block, to afford a bearing for the beam.

The rest of the uprights are to be each formed of a single round bar or rod with a collar and nut as above described at the upper end and passing through the center of the connecting block to be secured by a nut on the lower end, and to have an adjusting nut bear on the top of the iron needle beam. The diameters of the single uprights to be not less than 2 inches for spans of 90 to 120 feet, and one and three-fourths inches for spans of 50 to 90 feet for single roadways without sidewalks. For double roadways and bridges with sidewalks the size of both single and double uprights to be increased, as may be directed by said engineer.

The diagonals are to be two, crossing each other in each of the quadrilateral panels of the truss of one and one-eighth inch round iron in all sidewalk bridges of 75 feet span, and of one inch iron for all other bridges except when otherwise particularly specified. They are to be formed with a strong eye at the upper end for the upright, and bent near the eye so that it may fit horizontally upon the collar of the upright, or upon the eye of the diagonal connecting at the same point. Where the diagonals go on to the uprights the one running downward towards the center of the truss is to go on last or above the other; and the bend at the eye is to be close to the outer edge of the collar, or of the other eye upon which it bears.

The lower end of the diagonal is to pass obliquely through the connecting block with a screw nut at the end for adjustment, the screw being cut at least eight inches from the end, and to have a diameter one-fourth inch larger than the rest of the rod.

The nuts on both uprights and diagonals to be hexagonal, and properly proportioned for the purpose intended.

There shall be a pair of diagonal sway rods in each panel of the bridge; those in the end panels to be seven-eighths, and in the intermediate panels three-fourths inch round iron, and in bridges of 90 to 120 feet span there shall be two pairs at each end of seven-eighths inch iron. The sway rods are to be connected with the single uprights of the trusses at the upper side of the connecting blocks by eyes through which the uprights shall pass, and in a similar manner to a horn cast on the upper side of the crotch rod saddles. The sway rods to have turn buckle adjustment near one end, the screwed portion being enlarged one-fourth inch.

At the ends of the bridge the sway rods are to connect by eyes with the screws and nuts uniting the chords with he feet of the arches, or in any other convenient and substantial manner.

The sidewalk railing is to be of wrought iron except the corner posts, and when not otherwise specified is to consist of vertical posts of one and one-eighth inch square iron once in 4 to 5 feet; a bottom rail of 1 inch square iron about 4 inches above the bottom of the posts; a top rail of one and three-fourths inch by one-half inch iron flatwise on the top of the post, with a strip of one inch by one-fourth inch on the top of the last; and balusters of three-fourths inch square iron once in 6 inches, doweled and riveted to and between the top and bottom rails. At the bottom of each post and crosswise of the railing is to be a foot piece 6 to 7 inches long, two and one-half inches wide and half an inch thick, firmly riveted to the bottom of the post, and having two holes one on each side of the post, and about three and one-half to 4 inches from center to center for bolting down to the wood work with five-eighths inch bolts. On the outside of the railing the foot-plate is to be welded to the lower end of a scroll or ogee brace of three-fourths inch square iron, running up and riveted to the post about midway of its length.

The posts at the ends of the railing or at the corners of the bridge are to be of hollow cast iron 3 to 4 inches in diameter, and of any neat and comely pattern approved by the engineer.

The wrought iron work is to be made of the best qualities of American rolled iron for all parts except sidewalk railings, which may be made of good common English bar iron.

NEEDLE BEAMS.

The trusses are to be connected by cross girders (or needle beams) of wrought iron one at each upright, and resting upon the eyes of the sway rods at the single uprights, and on cast iron thimbles or washers at the double ones. The cross girders to consist of a vertical web plate one-fourth of an inch in thickness, with top and bottom flanges each of two angle irons, riveted on with three-fourths inch rivets having 4-inch pitch; the beam to have suitable holes for uprights, and be of such depth, length and form as shall be shown upon the drawings exhibited for letting, or as may be directed by the said engineer. When required solid wrought iron beams to be inserted in lieu of vertical web plate beams, and to be so proportioned as to give the requisite cross sections for the variable spans proposed.

FLOORING.

The joists are to be of good pine timber with a depth equal to about one-twelfth of their length between bearings; placed not over 28 inches apart from center to center, nor

more than 6 inches from the ends of the plank (or more than 4 inches in case of sidewalk plank), and to have an aggregate thickness in carriage-ways not less than 17, and in sidewalks one-eighth the length of plank or width of flooring supported.

When not otherwise specified the carriage-ways are to be planked with two and one-half inch oak spiked crosswise upon the joists with 6-inch cut or wrought spikes having a cross section not less than one inch to each 5 square feet of plank. Sidewalks to be planked with 2-inch pine plank, spiked with 5-inch spike or nails.

Under each arch truss just above the flooring is to be a coping of 2-inch pine plank not less than 2 feet wide, consisting of 2 strings of plank one on each side of the uprights and diagonals, and fitted about them so as to bring their edges together at the center of the truss, the outer edges coming just over the ends of the floor plank, and being supported by the cross pieces between the joists on either side of the truss.

In bridges without sidewalks the outer coping to be 15 inches wide with a facic plank of a proper depth, and one and one-half inches in thickness under the coping, placed two and one-half inches from the outer edge.

On the outside of sidewalks is to be a stringer 9 or 10 inches deep and 6 inches thick with its upper side about one-half inch above the sidewalk plank and surmounted by a coping 3 by 10 inches, beveled about 2 inches by one-half inch on the upper corners, with grooves three-eighths inch wide and five-sixteenths deep on the under side, and about one-half inch from each edge.

Upon this coping near the center the railing is to be secured by two five-eighths bolts to each post passing through coping and stringer, and through the ends of needle beams when practicable. But when this is not convenient the stringer may be first bolted firmly to the ends of the beams, and the railing bolted only to the stringer and coping. Both heads and nuts are in no case to act against wood without suitable iron washers.

All the coping, facing plank and rail stringers to be of good pine timber, planed on the upper and outer surfaces and edges, and painted with at least two good coats of white lead or zinc paint and linseed oil.

All parts of the iron work which are accessible after the work is put together, are to be painted with two good coats of lampblack and boiled linseed oil, or other paints approved by the engineer in charge, except the under sides of the arch castings, which may be painted one good coat. Those parts of the trusses not accessible for painting after

being put together, are to be thoroughly painted at least one good coat before putting together.

The preceding specifications are intended to be applicable to all bridges upon the general plans here referred to, whether with two or a greater number of trusses.

In all cases not otherwise specified trusses are to be 19 feet apart between centers; and the center of sidewalk railing, when used 6 feet from the center of truss.

For a more full and perfect explanation of the form and dimensions of all the work, and of the manner of executing it in all its details, plans and bills of timber will be furnished by the said engineer, who will also give such directions during the progress of the work as may appear to him necessary to have the same done in every respect complete and perfect, on the plan contemplated in the foregoing specifications; and the said directions shall in every respect be complied with.

GENERAL SPECIFICATION OF THE MANNER OF BUILDING SUPERSTRUCTURES FOR ROAD AND FARM BRIDGES OF SPANS NOT EXCEEDING 85 FEET.

For.....Canal.

Each superstructure to consist of a timber and plank flooring supported by 2 or more trusses of pine respectively placed not less than 12 and 11 feet apart for road and for farm bridges, and resting on abutments of masonry, or on well framed timber bents.

Each truss to consist of a main and sub-chord, the former to be spliced at the center with a notched and lapped joint 6 feet in length, and the latter to extend not less than 18 inches beyond its junction with the center or intermediate braces. Under each end of the main chord is to be placed a bolster not less than 5 feet in length.

The main and sub-straining beams are to run parallel with the chords, and to be connected with them by 3 or more pairs of braces, according to the span required. At the center of the chord and under all but the outer braces are to be inserted oak or red beech needle beams, extending no less than 9 inches beyond the trusses, each being secured by a pair of diverging wrought-iron rods, passing through and connecting it with the straining beams.

Lateral braces of wood or iron are to be inserted diagonally between the needle beams and in the outer panels *connected* with the wall plates on which the trusses

The flooring to be of hardwood or hemlock plank two and one-half inches thick supported by pine or hemlock joists, laid not more than 30 inches apart from center to center. At the edges of the flooring each truss to be protected by beveled fender timbers, and when directed the plank to be well spiked to the floor joists.

The chords, bolsters, straining beams, braces, needle beams, etc., to be firmly secured by wrought iron bolts and nuts and cast-iron washers, the whole to be made of the best kind of American or Swedish iron.

All the timber used to be of sound and good quality, well seasoned and free from shakes and knots. Everything brought on the work to be subject to the inspection of the resident engineer, and in all cases whatever he may not approve shall at once be removed and proper materials substituted.

The whole superstructure to be framed and fitted in the most workmanlike manner, and placed upon the abutments ready for use. The truss proper to be smoothly planed, the wood and iron work painted with 3 coats of the best white lead and linseed oil, and afterwards well sanded.

If required white oak or red beech snubbing posts to be set at each end of the bridge, and proper guard chains attached.

For a more full and perfect explanation of the form and dimensions of the work, and of the manner of executing it in all its details, plans and bills of timber will be furnished by the engineer in charge, who, during the progress of the work, will give all necessary directions as so everything contemplated in the specification, and the tame shall in all respects be complied with.

Mineral Lease.

FORMS FOR PROCURING THE SAME.

THIS INDENTURE, made this.....day of... .... in the year 18..., between.....and..... of the first part, and ..... of the second part,—

WITNESSETH,—

That in consideration of the covenants hereinafter agreed to be performed by the party of the second part, the party of the first part have granted, devised and leased, and by these presents do grant, devise and lease unto the said party of the second part his personal representatives and assigns, the exclusive right to mine and remove or manufacture iron ore on their land lying in the county of.....State of.....containing.....acres, for the period of twenty-five years from the date of this lease. And the parties of the first part agree that the party of the second part, his personal representatives or assigns, shall have the unrestricted right of ingress and egress on said laid, for himself, his agents, servants and teams for the purpose of making explorations, and for mining, removing or manufacturing said ore, and the said party of the second part shall have the right to make all necessary excavations to ascertain the extent and value of the mineral properties in said land without charge, and shall also have the right to cut and use any timber on said land which may be needed for mining purposes or for the use of his employes.

The party of the second part covenants and agrees that he will commence his mining operations on said land within.....from this date, and that he will pay the parties of the first part.....cents royalty on each ton of iron, coal or other mineral ore of 2,240 pounds mined and removed from or manufactured on said land; and is further covenanted and agreed by the parties of the first part, that if for any cause the party of the second part shall fail to commence his mining operations within the period specified, that he shall have the privilege of continuing this lease by paying an annual rent of..... dollars, said rent to commence at the expiration of the time within which he has agreed to commence said operations, and to continue at that rate until the said mining op-

erations shall be actually commenced, at which time said rent shall cease, and the royalty above agreed upon shall be paid. It is further covenanted and agreed between the parties that if the party of the second part shall fail to commence his mining operations within the period named, and shall fail to pay the annual rent agreed to be paid at the expiration of said period, then this lease shall be void. It is further agreed by the parties of the first part that the party of the second part shall have the right to continue this lease for a period not to exceed fifty years from this date, should he so elect upon his paying the royalty agreed upon, or the annual rent in lieu thereof. And the party of the first part agree that the party of the second part shall have the right to remove all buildings, machinery and fixtures from said land erected by him during the continuance of his lease, provided the said party of the second part shall have paid all the royalty due for the ore mined and removed from or manufactured on said land.

Witness the following signatures and seals.

.....(Seal.)
.....(Seal.)

.....
.....

State of....., }
.....County, } *ss.*

We....., Justices of the Peace in and for the County and State aforesaid, certify that.....whose name is signed to the writing above, bearing date the.... ....day of.....18.., has acknowledged the same before us in our county aforesaid; and we further certify that.... .....wife of.....whose names are signed to the writing within dated the.....day of.....18.., personally appeared before us in our county aforesaid, and being examined by us privily and apart from her husband, and having the writing aforesaid fully explained to her she, the said.....acknowledged the said writing to be her act, and declared that she had willingly executed the same and does not wish to retract it. Given under our hands this.....day of.....18...

....., J.P.
....., J.P.

Option — Article of Agreement.

THIS ARTICLE OF AGREEMENT, made and entered into on the.....day of.....18..., between .....and.....his wife, of the county of.....and State of,.....of the second part,—

WITNESSETH,—

That the parties of the first part have this day sold to the party of the second part, all that tract of land situated in.....and bounded and described as follows, to-wit:

.....

.....

for the sum of $.....to be paid as follows, to wit: $.....in hand paid, the receipt of which is hereby acknowledged, and the residue in payment as follows, to-wit:

.....

.....

It is further agreed by and between the parties to this agreement, that this sale shall be at the option of the party of the second part, and that the party of the second part has .....year..from this date to elect whether he will accept or reject the terms of this sale as set out in this agreement, any rejection within the time to be endorsed on this agreement, and a non-compliance within the time by the party of the second part, to be taken and accepted by the parties of the first part as a rejection of the terms thereof.

The parties of the first part are to have control of the premises, and pay the taxes thereon until notified by the party of the second part of his intention to confirm this sale, at which time and upon the application of the party of the second part the parties of the first part bind themselves to make or cause to be made a good and sufficient deed with covenants of general warranty for said land to the party of the second part, or to his assignee or assignees.

It is further expressly agreed by and between the parties to this agreement, that should the party of the second part fail or refuse to confirm this sale within the time *above* specified, then the money in hand paid is forfeited

unto the parties of the first part, and is to be taken and accepted in full satisfaction of all damages, if any, they sustain by reason of the party of the second part refusing or failing to confirm ths sale.

In witness whereof we have set our hands and seals on the day and year first above written.

Attest: { .....(Seal.)
{ .....(Seal.)

State of....., } ss.
County of..... }

I, ..., a ..... in and for said county, do certify that.....and.....his wife, whose names are signed to the writing above, bearing date on the.... ....day of.....188.., personally appeared before me in my said county, and acknowledged the signing and sealing of the same, and I do further certify that..... wife of.....whose names are signed to the foregoing writing, bearing date on the.....day of.....188.., personally appeared before me in my said county, and being examined by me privily and apart from her said husband, and having the said writing fully explained to her, she, the said.....acknowledged the said writing to be her act, and declared that she had willingly executed the same, and does not wish to retract it.

Given under my hand this.....day of.....188..

.....

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